

**DRAFT**  
**Chapter 6 – Haw River Subbasin**  
**HUC 03030002**

**BASINWIDE WATER RESOURCES  
MANAGEMENT PLAN**

**CYCLE 4 –  
CAPE FEAR RIVER BASIN 2026**

North Carolina  
Department of Environmental Quality  
Division of Water Resources  
Basin Planning Branch



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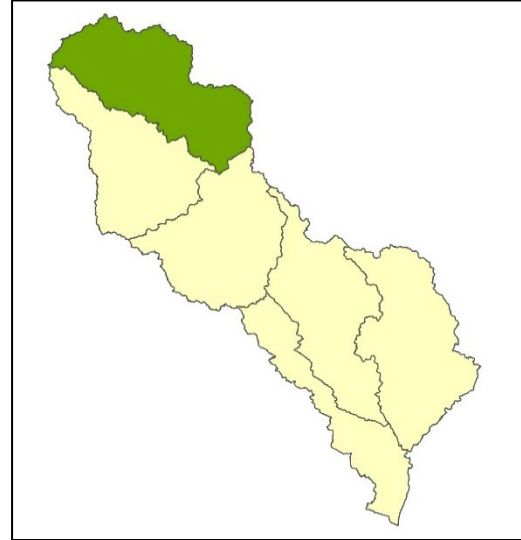
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## 6 Haw River Subbasin (HUC8 03030002)

### 6.1 General Description

The Haw River subbasin is in the northwestern portion of the Cape Fear River Basin located entirely within the Piedmont ecoregion. The 8-digit hydrologic unit code (HUC) boundary (03030002) covers 1,707.6 square miles (mi<sup>2</sup>) or 1,092,858 acres encompassing most of Alamance and Guilford counties as well as eastern portions of Rockingham, Caswell, Orange, Durham, Wake and Chatham counties. Greensboro and Durham are the largest municipalities in this subbasin. Other larger communities located entirely or partially within this subbasin include Chapel Hill, Carrboro, Burlington, Mebane, Summerfield, Elon, Graham, Kernersville and several rapidly growing western Wake County communities in the Triangle region including Cary, Apex, Holly Springs, Morrisville and Fuquay-Varina (*Figure 6-1 to Figure 6-5*).



The Haw River flows east from Kernersville toward Burlington where it turns to the southeast and continues to the confluence with the Deep River below Jordan Lake at the boundary with the Upper Cape Fear and Deep River subbasins. Major tributaries of the Haw River include Reedy Fork and North and South Buffalo creeks located in the headwaters near Greensboro; Stoney, Back, Big Alamance and Stinking Quarter creeks located in the middle of the subbasin near Burlington; and Northeast and New Hope creeks which flow into Jordan Lake in the lower section of the subbasin. The Haw River subbasin is comprised of seven HUC10 watersheds.

The Piedmont ecoregion where the Haw River subbasin is located includes portions of the Triassic Basin and Carolina Slate Belt Level IV ecoregions. The Triassic Basin is a narrow band located above and to the southeast of Jordan Lake. This ecoregion is characterized by erodible rocks, which promote unstable stream banks and increase sediment loads, and low permeable clay rich soils that cause low baseflows, especially during warm seasons when many streams completely dry up (Griffith et al. 2002). The Carolina Slate Belt is a wide belt that traverses the middle subbasin and is adjacent to the Triassic Basin. This ecoregion has low warm season stream flows and the lowest water yielding rock units in the state, which creates challenges for groundwater wells installed in this region (Griffith et al. 2002).

There have been several water resource-related issues highlighted in the Haw River subbasin which occurred during the timeframe of this plan, 2002 to 2020:

- Development of many Total Maximum Daily Loads (TMDL) for fecal coliform bacteria, turbidity/TSS and nutrients due to ongoing water quality concerns (sections 6.4, 6.6.6.9.1 and reviewed throughout the HUC-10 watershed writeups).

Figure 6-1: General Map of Monitoring Stations and Permitted Facilities in the Haw River Subbasin

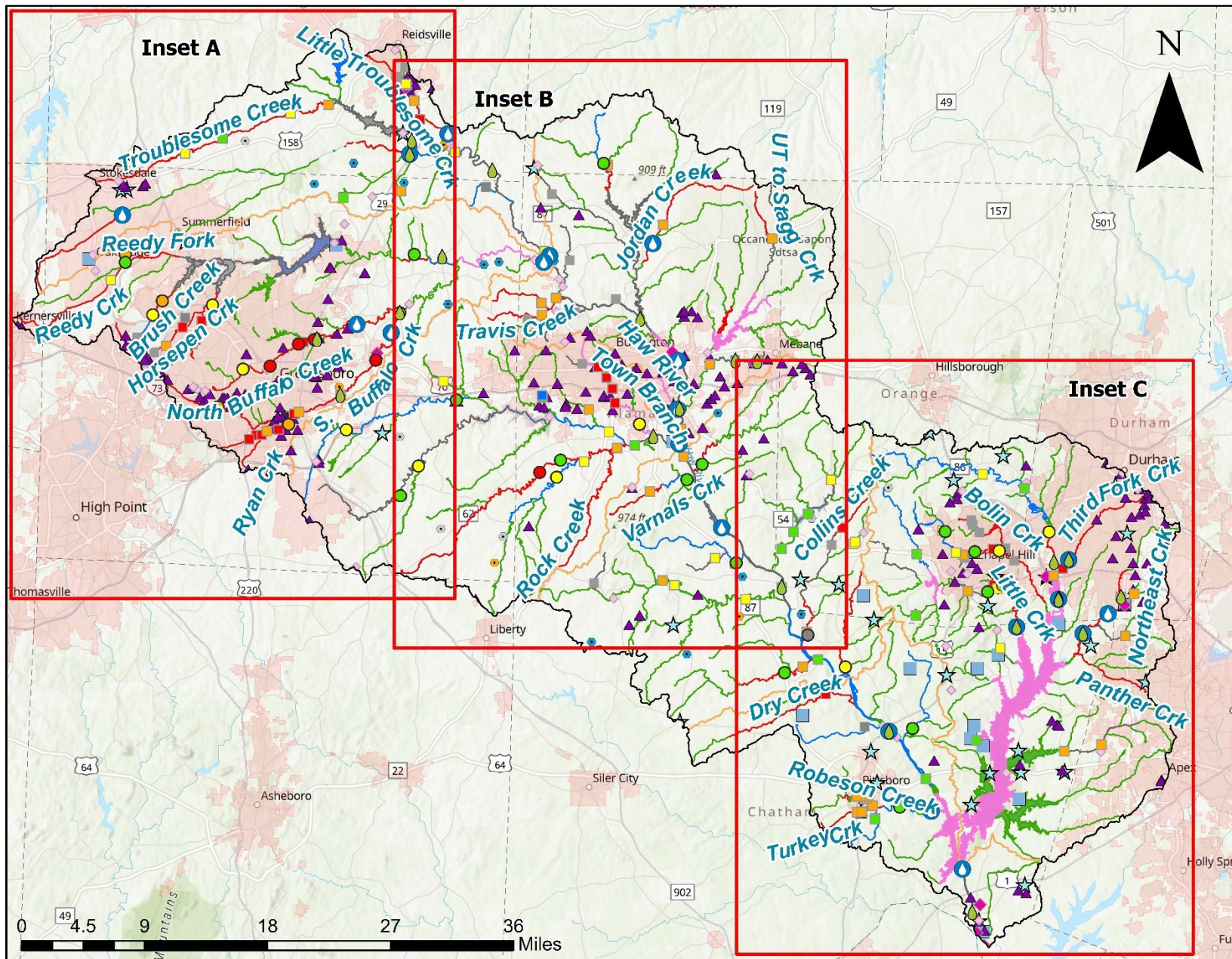


Figure 6-2: General map legend for Haw River subbasin

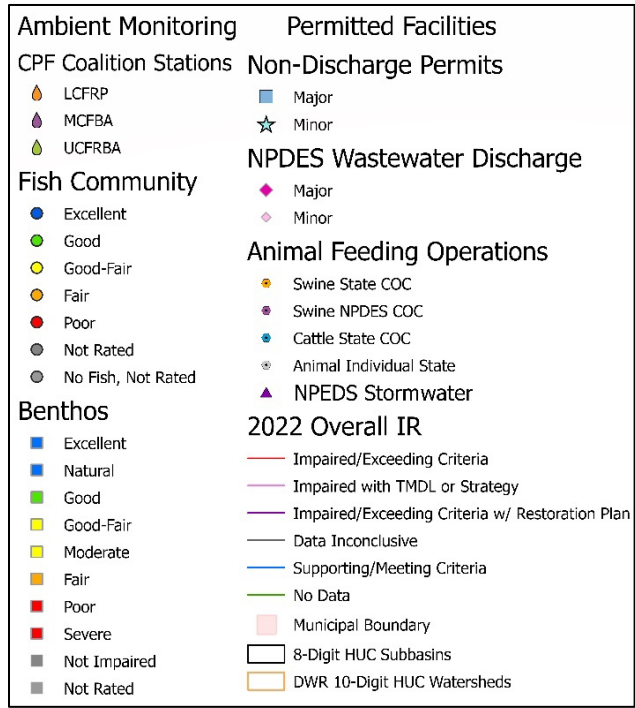


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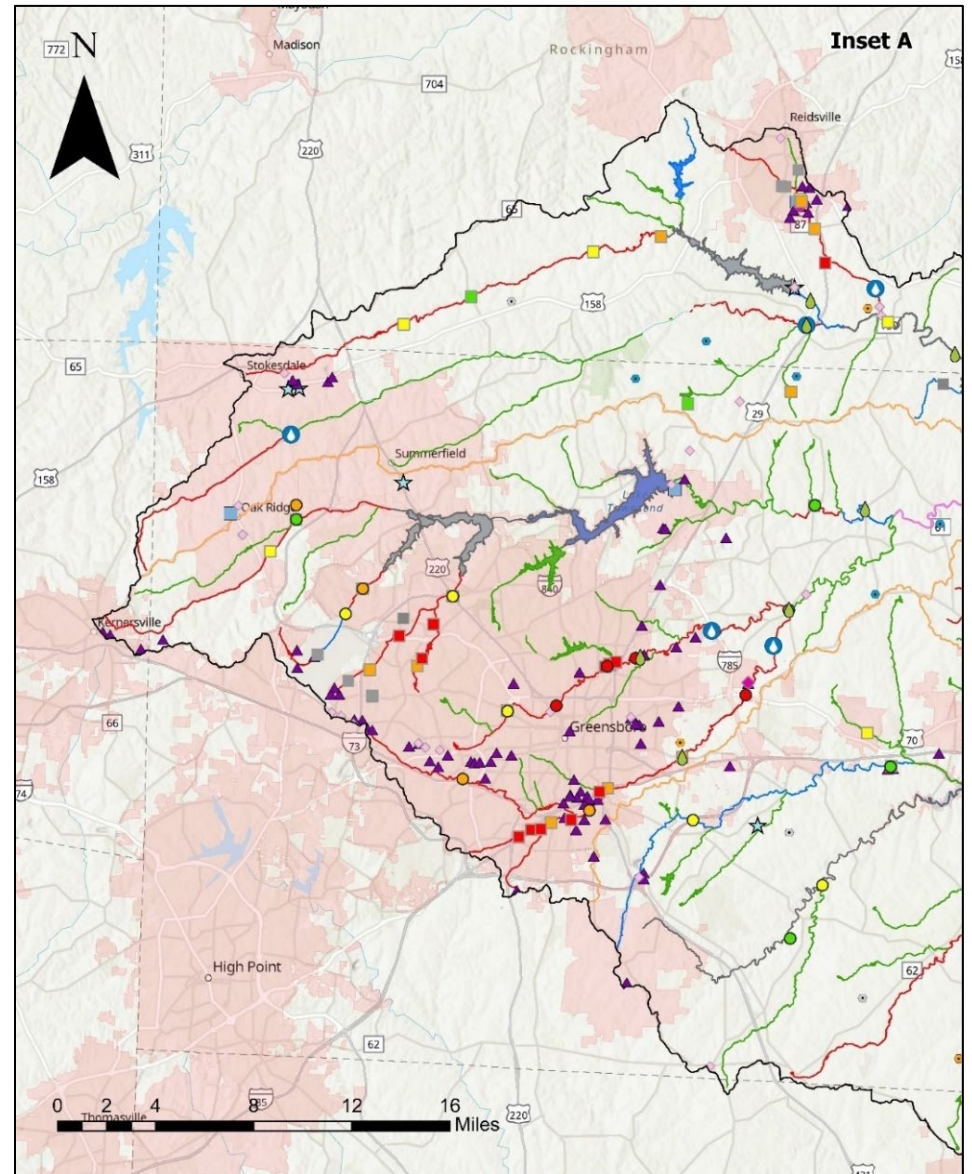


Figure 6-4: General map of monitoring stations and permitted facilities in the Haw River subbasin-Inset B

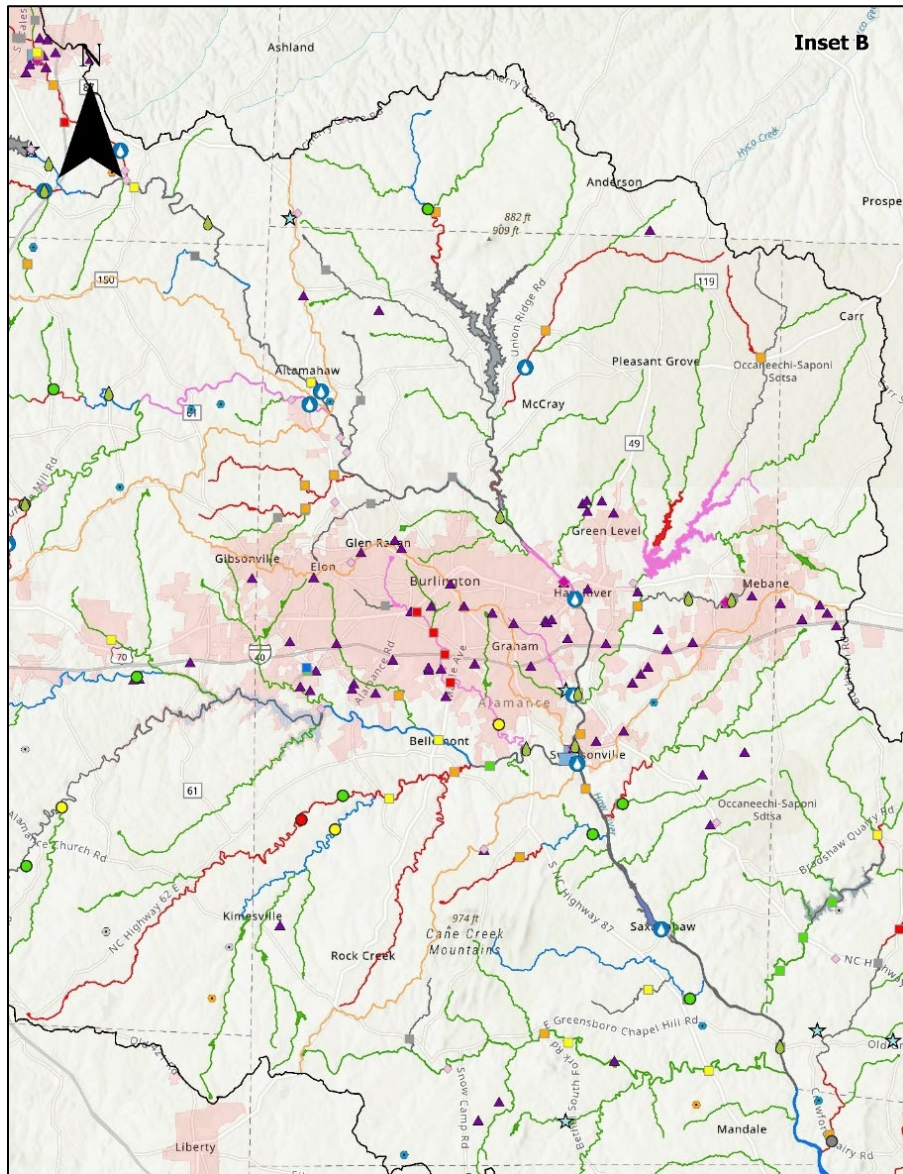
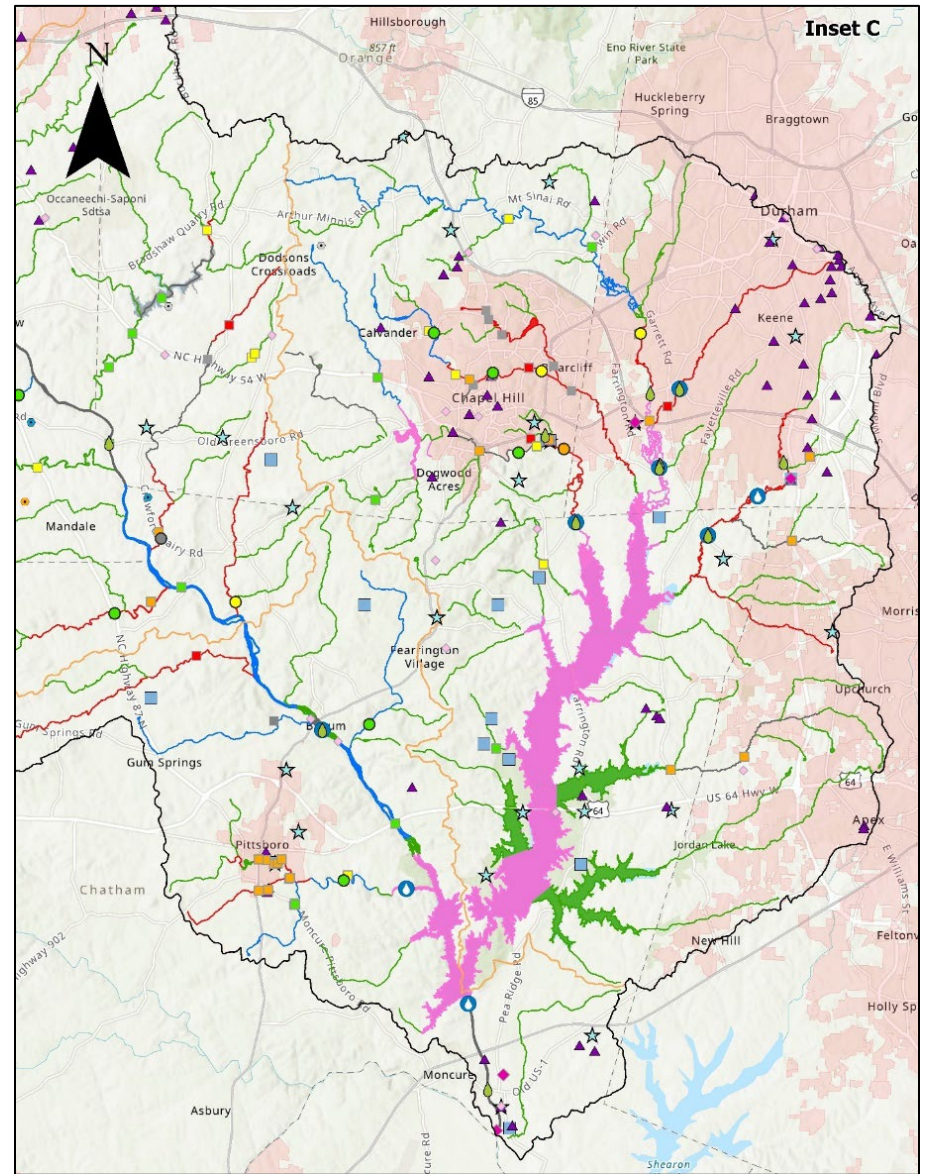


Figure 6-5: General map of monitoring stations and permitted facilities in the Haw River subbasin-Inset C



- Development of many Watershed Action Plans for several watersheds in the Haw River subbasin to address ongoing water quality concerns and impairments (section 6.5 and throughout the HUC-10 watershed writeups).
- Little Alamance Creek EPA approve 4b demonstration/TMDL alternative to address benthic macroinvertebrate impairment (sections 6.6.3, 6.6.3.2).
- 1,4-Dioxane discovered in surface waters and special study was initiated (sections 6.6.2.3, 6.3, 6.6.6.13).
- City of Greensboro T.Z. Osborne SOC to address 1,4-Dioxane contamination (section 6.6.1)
- City of Greensboro requested an emergency potable water supply intake on the Haw River (section 6.6.2.3)
- Reidsville moved discharge from Little Troublesome Creek to Haw River mainstem (section 6.6.2)
- Nutrient-enriched waters is a major concern throughout the entire Haw River subbasin (all watersheds discuss this issue).
- NC Policy Collaboratory Jordan Lake Study (section 6.6.6.9.3)
- Jordan Lake rules readoption (section 6.6.6.9.4, 6.6.6.9.4)
- Point source TN and TP discharge compliance (section 6.6.6.9.6)
- Jordan Lake round-4 water supply allocation (section 6.7.2)

The 2022 Integrated Report (IR) for the Haw River subbasin is summarized on [Table 6-1](#) and categorized by parameter in [Table 6-2](#). Monitoring data was available for 45% of the freshwater (FW) miles of rivers and streams and 84% of the FW acres of lakes and reservoirs. The Haw River subbasin had more impairments than any other subbasin in the Cape Fear River Basin on the 2022 IR, accounting for close to half (47.9%) of the impaired FW miles and over 90% of the FW acres. The 2022 IR found more than 50% of the monitored FW miles (308.5 miles) and 71% of the monitored FW acres (11,287 acres) were exceeding criteria/impaired and not meeting their intended uses ([Table 6-1](#)). Many of the impairments were associated with urban areas, although several impairments also occurred in more rural areas ([Figure 6-1](#) to [Figure 6-5](#)). These impairments include AUs that are exceeding criteria and 303(d) listed (Category 5) and AUs that are exceeding criteria with a total maximum daily load (TMDL) or management strategy (Category 4). Most of the impaired FW acres have a TMDL or management strategy and 5% of FW miles also have a TMDL. In addition to TMDLs in the Haw, there is one 4b demonstration plan for Little Alamance Creek, (see section [6.4](#) and [6.5](#) for more information on watershed action plans and TMDLs). There is a Jordan Lake Nutrient Sensitive Waters (NSW) Strategy that covers the entire watershed above Jordan Lake Dam which is intended to address nutrients (N and P) throughout the watershed. Also see Chapter 2 for more information on the integrated report or the Chapter 2 Appendix for a full list of individual 2022 IR impairments.

Table 6-1: Haw River Subbasin 2022 Integrated Summary

Assessment Unit <sup>1</sup>	Map Color	FW Miles <sup>2</sup>	FW Acres <sup>2</sup>
Total	All Colors Combined	1,307.0	19,144.2
Total Monitored	Combined Blue, Gray, Red, and Pink	582.7	16,034.5
Not Monitored	Green	724.3	3,109.7
Meeting Criteria (Category 1)	Blue	139.5	176.4
Data Inconclusive (Category 3)	Gray	134.7	4,482.3
Exceeding Criteria 303(D) (Category 5)	Red	277.0	107.2
Exceeding Criteria with TMDL (Category 4)	Pink	31.5	11,268.6
Exceeding Criteria (Combined Category 4 and 5)	Combined Red and Pink	308.5	11,375.8
% Exceeding of Monitored Exceeding (Combined Category 4 and 5)	Combined Red and Pink / Total	52.9%	70.9%

<sup>1</sup>All waterbodies in North Carolina are impaired for Fish Tissue Mercury and are not included on this table.

<sup>2</sup>FW - Freshwater

Impairments to rivers, creeks, and streams were most frequently attributed to benthos communities and the most common impairment to FW acres was due to chlorophyll *a*, accounting for 222.6 FW miles and 11,460.5 FW acres, respectively. (Table 6-2). Other more common impairments include 70.8 FW miles for fish community, 45.9 FW miles for metals (5.6 dissolved copper, 25.7 total copper, 14.6 total zinc), 56.1 FW miles for fecal coliform, 3,752.1 FW acres for turbidity, and 2,761.9 FW acres for pH. TN and TP were identified as the causal parameters resulting in the chlorophyll *a* response and added to category 4 of the integrated report (Table 6-2).

Table 6-2: Haw River Subbasin 2022 Impairments by Parameter (Category 4 and 5)

PARAMETER (Category 4 and 5 Combined) <sup>1,2</sup>	FW Miles <sup>3</sup>	FW Acres <sup>3</sup>
Aquatic Passage	8.6	0.0
Benthos (Nar, AL, FW)	222.6	0.0
Chlorophyll <i>a</i> (40 µg/l, AL, NC)	11.3	11,460.5
Copper (7 µg/l, AL, FW)	25.7	0.0
Copper Dissolved Chronic (Calculated, AL, FW)	5.6	0.0
Dissolved Oxygen (4 mg/l, AL, FW)	7.0	0.0
Fecal Coliform (GM 200/400 5 in 30, REC, FW)	21.5	0.0
Fecal Coliform (GM 200/400, REC, FW)	34.6	0.0
Fish Community (Nar, AL, FW)	70.8	0.0

PARAMETER (Category 4 and 5 Combined) <sup>1,2</sup>	FW Miles <sup>3</sup>	FW Acres <sup>3</sup>
Hydraulics	8.6	0.0
pH (9.0, AL, FW)	0.0	2,761.9
Total Nitrogen	0.0	11,375.9
Total Phosphorus	0.0	11,375.9
Total Suspended Solids	3.9	3,644.9
Turbidity (25 NTU, AL, FW acres & SW)	0.0	3,752.1
Turbidity (50 NTU, AL, FW miles)	14.8	0.0
Zinc (50 µg/l, AL, FW)	14.6	0.0

<sup>1</sup>Waterbody Uses: AL - Aquatic Life, REC - Recreation.

<sup>2</sup>Waterbody Type: FW - Freshwater, SW - Saltwater, NC - All North Carolina waters.

<sup>3</sup>Other: GM - Geometric Mean, Nar - Narrative.

The Haw River subbasin has more than 1,300 classified FW miles and more than 19,000 classified FW acres, summarized in [Table 6-3](#). The Haw River subbasin accounts for more than half (55%) of the FW acre lakes and reservoirs (19,144.2 FW acres) in the Cape Fear River Basin. The Haw also has the most Water Supply (WS) FW miles and FW acres in the basin with nearly 100% of the waterbodies classified as WS. The majority of the WS is classified as WS-IV, including Jordan Lake. Close to 60% of the FW acres in the Haw River subbasin are classified for primary contact recreation, Class B (i.e., swimming, etc.). The Quaker Creek and Stoney Creek reservoirs and their tributaries, both located in the Back Creek-Haw River watershed (HUC10 0303000204), are classified as High Quality Waters (HQW). The upper part of Cane Creek and its tributaries are also classified as HWQ in the Cane Creek-Haw River watershed (HUC10 0303000205). All the surface waters in the Haw River watershed are classified as Nutrient Sensitive Waters (NSW).

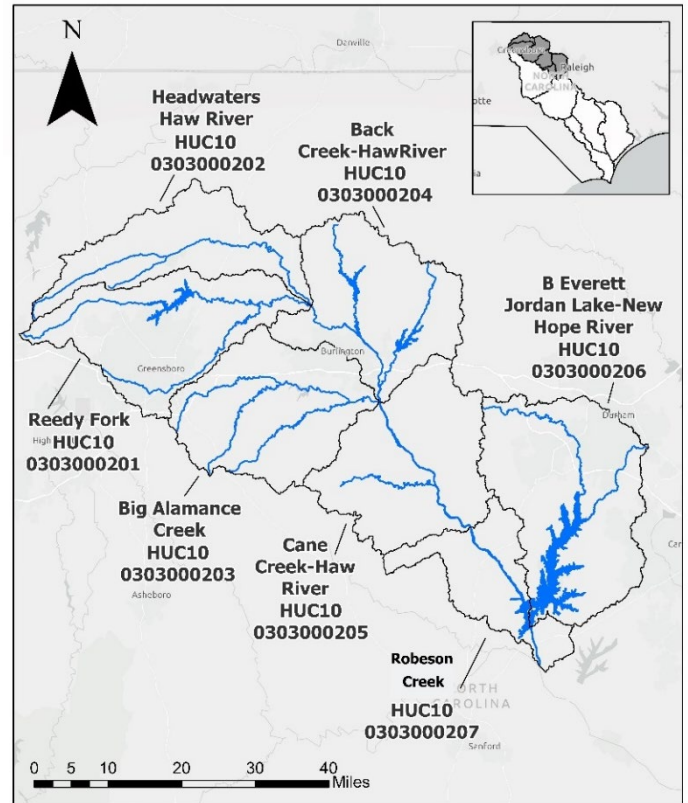
*Table 6-3: Haw River Subbasin Surface Water Classifications*

Classification*	Freshwater Miles	Freshwater Acres
C	1,307.1	19,144.2
B	35.6	11,066.6
WS-II	171.5	2,218.0
WS-III	77.4	3,495.9
WS-IV	360.1	13,296.8
WS-V	661.2	133.5
<b>WS TOTAL</b>	<b>1,270.2</b>	<b>19,144.2</b>
CA	45.0	17,744.4
NSW	1,259.4	19,144.2
HQW	171.5	2,218.0

\*Waterbody Classification C - Aquatic life propagation and secondary recreation, B - Primary contact recreation, WS - Water Supply, CA - Water Supply Watershed Critical Area, NSW - Nutrient Sensitive Waters, HQW - High Quality Waters

### 6.1.1 Population and Land Use

Based on the 2020 Census data (*Table 6-4*), the population in the Haw River subbasin is estimated to be more than one million people (1,000,759), having grown by 15% and more than 150,000 during the last 10-year Census period. The most populated municipalities are Greensboro, with a population of 299,035 and Durham, with a population of 283,506. All HUC10 watersheds experienced increased population growth. The Jordan Lake-New Hope River watershed (HUC10 0303000206), where the Durham and western Wake County suburbs are located, is the most populated, with close to 380,000 residents. This watershed also had the largest population increase (84,500) and the fastest growth rate (28.7%) from 2010 to 2020. The Reedy Fork watershed (HUC10 0303000201), where Greensboro is located, is the second most populated watershed with 317,300 and a population increase of 27,400, or 9% over the same time period. Reedy Fork is also the most densely populated, with 1,244 people per mi<sup>2</sup>; it is followed by the Jordan Lake-New Hope River watershed with 1,106 per mi<sup>2</sup>.



*Table 6-4: Estimated population of the watershed boundary scale (HUC 10)*

HUC10 Watershed Name	HUC10	Land Area (mi <sup>2</sup> )	Population 2010	Population 2020	Population Density 2020 (pop/mi <sup>2</sup> )	2010-2020 Population Change
Reedy Fork	0303000201	255	289,956	317,346	1,244	+27,390
Headwaters Haw River	0303000202	189	38,246	41,423	219	+3,177
Big Alamance Creek	0303000203	262	97,745	114,243	436	+16,498
Back Creek-Haw River	0303000204	251	79,245	88,529	353	+9,284
Cane Creek-Haw River	0303000205	270	31,333	37,292	138	+5,959
B Everett Jordan Lake-New Hope River	0303000206	343	294,770	379,273	1,106	+84,503
Roberson Creek-Haw River	0303000207	137	14,905	22,653	165	+7,748
<b>Haw River Subbasin Total</b>		<b>1,707</b>	<b>846,200</b>	<b>1,000,759</b>	<b>586</b>	<b>+154,559</b>

Table data is from NC One Map US Census Block Data for 2010 and Esri Living Atlas for 2020 USA Census Redistricting Blocks processed for Cape Fear River Basin HUC10s.

Land cover provides a perspective for which to view the water quality in the Haw River subbasin. Developed lands, agricultural lands, forest lands and grass/shrub covered lands all engage with the environment to influence the water quality. The National Land Cover Dataset (NLCD) was analyzed for the Haw River subbasin for 2001, 2011 and 2019, and is summarized in *Table 6-5* at the HUC10 watershed scale and *Table 6-6* at the HUC10 scale. The Haw River subbasin 2019 land cover was primarily dominated with forest (47%), development (24%), and agriculture (20%). A spatial distribution of the 2019 land cover is displayed in *Figure 6-6*. Developed land increased by of 57 mi<sup>2</sup> over the 18-year 2001 to 2019 time-period (*Table 6-5*), likely much of this was due to the conversion of agriculture and forested lands to development. During this same time period, agriculture cover decreased by 33 mi<sup>2</sup> and forest cover decreased by 50 mi<sup>2</sup>. Grassland/shrub cover also increased by 25.5 mi<sup>2</sup>, likely due in part to timber harvests. Development patterns mirror population patterns with the most developing areas in watersheds experiencing the most population growth. Studies show that if urbanized areas cover more than 25% of a watershed, there is a point where the decline in the health of the ecosystem is irreversible (Beach, 2002; Galli, 1991). The Reedy Fork watershed has the highest percent development, 47.2%, followed by the Everett Jordan Lake-New Hope River watershed at 34%. The Big Alamance Creek watershed (HUC 0303000203), which includes a portion of Burlington, is also close to that 25% threshold (23.3%). The B Everett Jordan Lake-New Hope River watershed had the largest increase in development, 23.5 mi<sup>2</sup>, from 2001 to 2019, with 5 mi<sup>2</sup> just from 2016 to 2019. The Reedy Fork watershed had 11.9 mi<sup>2</sup> of development over the same time period.

*Table 6-5: Land cover of the Haw River subbasin*

Land Cover <sup>1</sup>	2001	2011	2019	Net Change <sup>4</sup> 2001-2019	% Change <sup>5</sup> 2001-2019	mi <sup>2</sup> Change 2001-2019	Total mi <sup>2</sup> 2019
<b>Agriculture</b>	21.78%	20.28%	19.85%	<b>-1.93%</b>	<b>-8.87%</b>	<b>-32.99</b>	<b>338.89</b>
<b>Barren Land<sup>3</sup></b>	0.08%	0.09%	0.10%	<b>0.02%</b>		<b>0.29</b>	<b>1.67</b>
<b>Developed</b>	21.05%	23.42%	24.38%	<b>3.34%</b>	<b>+15.85%</b>	<b>56.95</b>	<b>416.33</b>
<b>Forest</b>	50.39%	47.53%	47.46%	<b>-2.94%</b>	<b>-5.83%</b>	<b>-50.13</b>	<b>810.38</b>
<b>Grassland/Shrub</b>	2.18%	4.24%	3.68%	<b>1.49%</b>		<b>25.48</b>	<b>62.79</b>
<b>Open Water</b>	2.65%	2.56%	2.70%	<b>0.05%</b>		<b>0.89</b>	<b>46.06</b>
<b>Wetlands</b>	1.87%	1.88%	1.84%	<b>-0.03%</b>		<b>-0.48</b>	<b>31.47</b>
<b>Total mi<sup>2</sup></b>							<b>1,707.59</b>

<sup>1</sup>Data was downloaded from the Multi-Resolution Land Characteristics NLCD website and processed for each Cape Fear River Basin HUC8s in 2022.

<sup>3</sup> Barren Land is a catch-all category for tilled land, new development, cutover, bare rock areas.

<sup>4</sup> Net change is the difference between 2019 and 2001 % land cover or (2019% - 2001%).

<sup>5</sup> The %

Change in square miles and is calculated as  $(((2019 \text{ mi}^2 - 2001 \text{ mi}^2) / 2001 \text{ mi}^2) * 100)$ .

Table 6-6: 2019 Land cover in the HUC10 watersheds of the Haw River subbasin

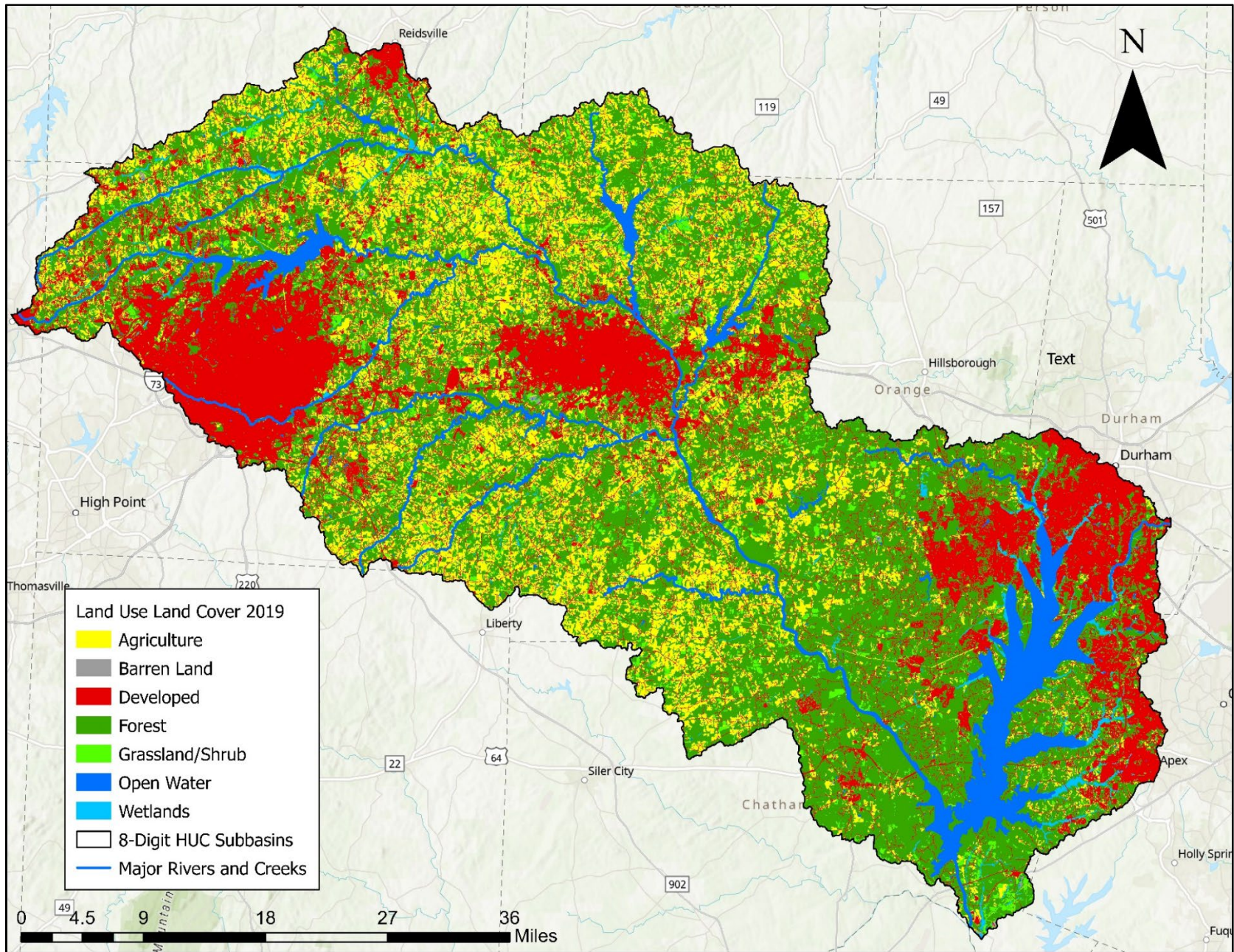
Watershed	Land Area (mi <sup>2</sup> )	Agriculture	Barren Land	Developed	Forest	Grassland Shrub	Open Water	Wetlands
Reedy Fork	255	15.9%	0.0%	47.2%	30.8%	2.7%	2.3%	1.1%
Headwaters Haw River	189	30.7%	0.1%	15.2%	44.6%	4.1%	1.7%	3.7%
Big Alamance Creek	262	26.6%	0.1%	23.3%	44.6%	3.6%	1.4%	0.4%
Back Creek-Haw River	251	28.1%	0.1%	19.1%	46.5%	4.0%	2.0%	0.4%
Cane Creek-Haw River	270	27.4%	0.0%	9.3%	57.5%	4.4%	1.1%	0.3%
B Everett Jordan Lake-New Hope River	343	4.7%	0.2%	34.4%	46.6%	2.6%	6.4%	5.1%
Roberson Creek-Haw River	137	7.5%	0.2%	10.9%	72.1%	5.7%	2.5%	1.1%

<sup>1</sup>Data was downloaded from the Multi-Resolution Land Characteristics NLCD website and processed for each Cape Fear River Basin HUC8 in 2022.

<sup>2</sup>Barren Land is a catch-all category for tilled land, new development, cutover, bare rock areas.

The upper three subbasins in the Cape Fear River Basin, including the Haw River, have the highest percentage of forest cover and have had the largest loss of forest cover since 2001 as compared to the lower three subbasins (see Chapter 1, Section 1.2.2). Forestry (silviculture) activities pose a potential nonpoint source of pollution and potential impact to water quality and stream habitat if forestry practices are poorly implemented or managed. Properly planned and executed forest management practices, however, facilitate the sustainable harvest of forest products while also protecting water quality. The North Carolina Forest Service (NCFS) is delegated the authority to monitor forestry operations in North Carolina for compliance with the “Forest Practice Guidelines (FPGs) Related to Water Quality.” The FPGs are a set of results-based guidelines meant to protect water quality and are mandatory statewide requirements defined by North Carolina Administrative Code ([02 NCAC 60C .0100-.0209](#)). BMPs, such as temporary bridges (e.g., bridgemats), can be used to ensure that the forest operators and landowners remain in compliance with the FPGs. The NCFS conducts [site surveys](#) across the state to assess the implementation of FPGs on timber harvests. The [Forest Development Program](#) (FDP), an afforestation or reforestation stand improvement cost-sharing program offered to private landowners, is also administered by NCFS. In addition, NCFS provides several types of management plans, such as a stewardship or pre-harvest plan, to private landowners (NCFS 2022). More information about FPGs, timber harvest inspections, FDPs, and management plans in the Cape Fear River Basin is available in Chapters 1 and 4.

Figure 6-6: Land Cover in the Haw River Subbasin



The total numbers, total acreage and subbasin percent for timber harvest inspections, forest management plans and afforestation/reforestation from May 1, 2005 to October 31, 2021 in the Haw River Basin is shown in *Table 6-7* and *Figure 6-7*. The distribution of forest management plans across the subbasin is also displayed in *Figure 6-8*. In the Haw River subbasin, during this 15+ year period, 5.8% of the subbasin was inspected for timber harvests, forest management plans were produced for 11.2% of the subbasin, and afforestation/reforestation management approaches were implemented in 2.3% of the subbasin (NCFS 2022). See Chapter 1 for the basinwide distribution of timber harvest inspections and Chapter 4 for the basinwide density of forest management plans and afforestation/reforestation management.

*Table 6-7: Haw River Basin NCFS Management Approaches May 2005 to October 2021 (NCFS 2022)*

NCFS Management Approach	Number	Total Acres <sup>1</sup>	% of Subbasin
<b>Harvest Inspections</b>	1,611	63,097	5.8%
<b>Forest Management Plans<sup>2</sup></b>	3,017	122,122	11.2%
<b>Afforestation/ Reforestation</b>	953	24,905	2.3%

<sup>1</sup>There are 1,092,854 total acres in the Haw River Basin

<sup>2</sup>Forest Management Plan types include Forest Management, Pre-Harvest, Practice, Regeneration, Rehabilitation, Replant, Stewardship and Urban plans.

*Figure 6-7: Haw River Subbasin Percentage of Area (Acres) Assisted by NCFS Services (NCFS 2022)*

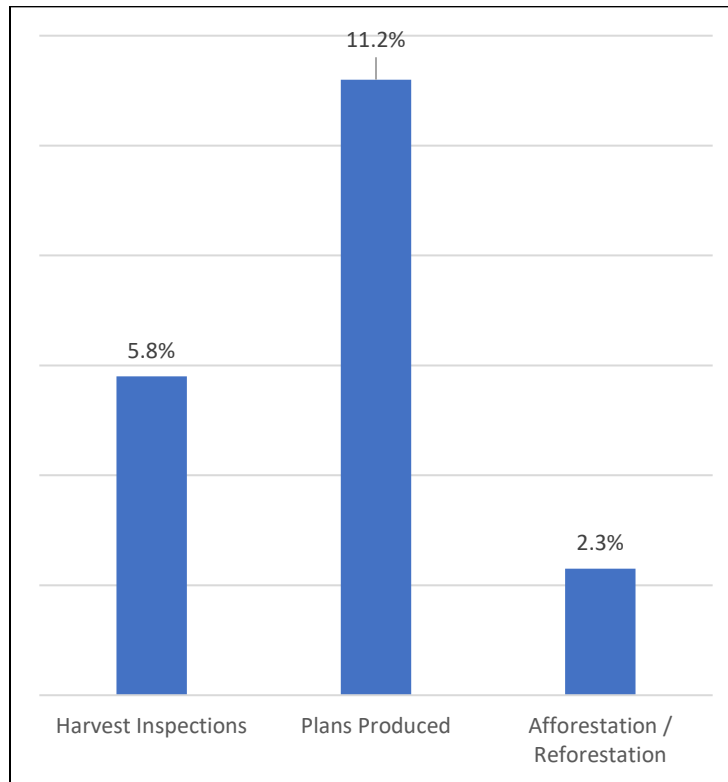
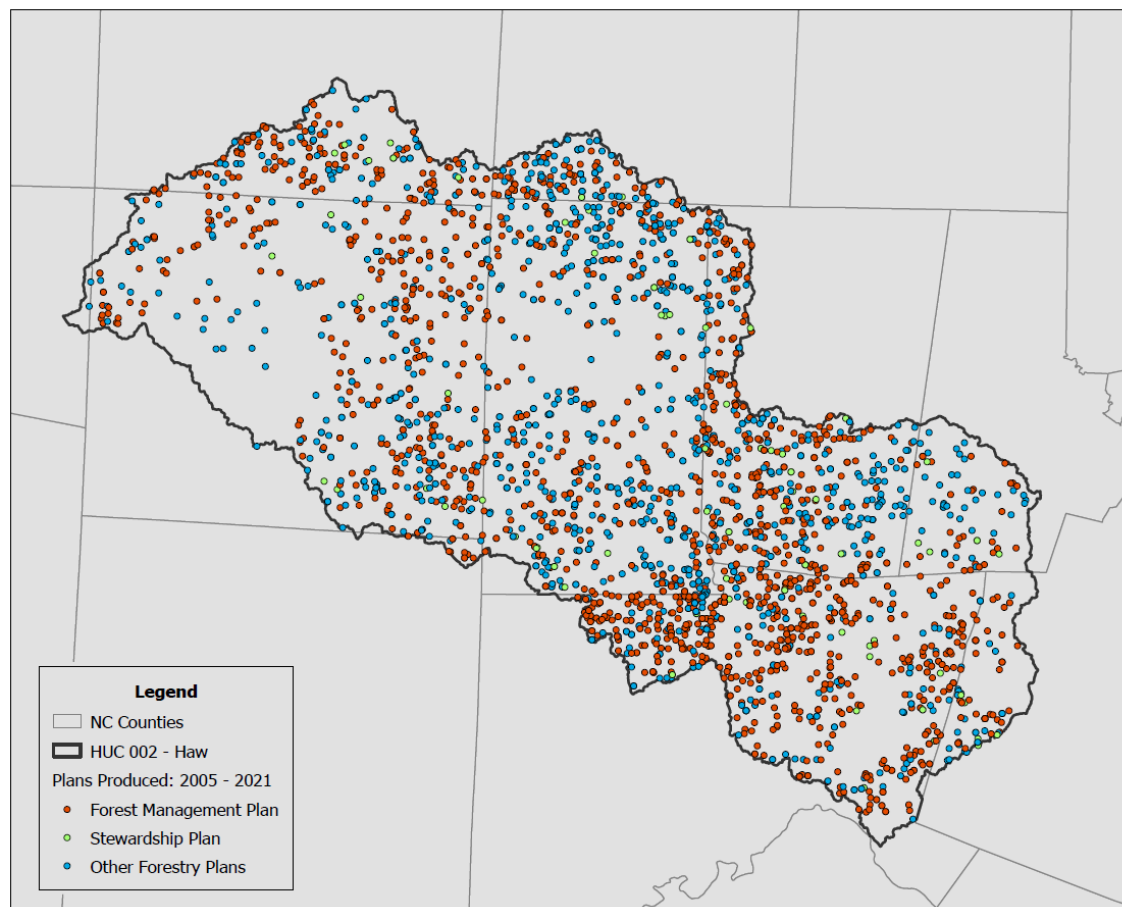


Figure 6-8: Haw River Distribution of Plans Provided by the NCFS from May 2005 to October 2021 (NCFS 2022)



In addition to permitted animal operations (AFOs) described in the next section, the US Department of Agriculture (USDA) 2017 [Census of Agriculture](#) data indicates there are poultry operations in Haw River subbasin counties. DWR has minimal information on the location of poultry operations or the location of where manure is transported and applied. Counties chosen for the census data evaluation of poultry operations within the Haw River subbasin have >50% land area within the Haw River subbasin boundary, except for Orange County, which has 48% land cover within the boundary ([Table 6-8](#)). Alamance County had the highest number for both inventory and production contracts over all the years queried, however, the Haw River subbasin counties have the lowest numbers for poultry overall when compared to the other Cape Fear River subbasins. In 2022, there were 1.1 million poultry for inventory and 2.3 million poultry for contract production in the Haw River subbasin. Additionally, poultry numbers decreased by 30% for inventory and 42% for production contracts between 2007 and 2022. This is likely due to the closure of several poultry processing plants in the area. However, Mountaire Farms processing plant opened in 2019 in Siler City and was processing 625,000 chickens per week with a capacity to process 1.4 million birds (Chatham News and Record, April 26, 2019). This new processing plant has resulted in new or re-established poultry operations which are likely not accounted for in the 2022 USDA agriculture census numbers. See Chapter 1 and the Chapter 1 Appendix for more information on the USDA census data.

Table 6-8: USDA Census data for Chicken (Broilers, Pullets, Layers and Roosters) in Haw River Subbasin Counties (2007, 2012, 2017 and 2022)

USDA Data	Alamance	Guilford	Orange	Total
<b>2007</b>				
Inventory <sup>1</sup>	1,104,268	305,483	111,592	1,521,343
Contract <sup>2</sup>	2,899,000	958,800	NA	3,857,800
<b>2012</b>				
Inventory <sup>1</sup>	286,395	322,885	153,605	762,885
Contract <sup>2</sup>	708,300	114,000	99,430	921,730
<b>2017</b>				
Inventory <sup>1</sup>	828,163	320,726	170,624	1,319,513
Contract <sup>2</sup>	2,045,444	293,000	122,462	2,460,906
<b>2022</b>				
Inventory <sup>1</sup>	847,256	9,215	212,996	1,069,467
Contract <sup>2</sup>	2,146,800	(D)	98,000	2,244,800

<sup>1</sup>USDA Inventory numbers represent a point in time (End of December) when the census data was collected for chickens only.

<sup>2</sup>USDA Production Contract numbers are "totals for the portion of agriculture production raised and delivered under production contract" (USDA, 2017) for chickens only. Production Contract and Inventory are not additive. They each represent different data items.

<sup>3</sup>Counties included in this table had >50% land area within the Haw River Subbasin, except for Orange which was 48%.

(D) - Indicates that numbers are withheld to avoid disclosing data for individual farms.

### 6.1.2 Permits

As of May 2022, there were 274 NPDES wastewater, 276 non-discharge and land application, 202 NPDES stormwater, 49 state stormwater and 23 animal feeding operation (AFO) permits issued in the Haw River subbasin (Table 6-9). A complete list of permits can be found in the Appendix for Chapter 3. Figure 6-9 shows the location of the permitted facilities in the Haw River subbasin. More information about the permitting programs can be found in Chapter 3, including a map of state stormwater facilities.

The Haw River subbasin accounts for over a third (146.73 MGD) of the total permitted as-built discharge (425.47 MGD) in the Cape Fear River Basin. There are 11 major NPDES municipal and industrial wastewater treatment plant (WWTP) permits and 54 minor NPDES wastewater (excluding single-family) permits in the subbasin with a total permitted as-built of 146.73 MGD (Table 6-9). Facilities designated as major are permitted to discharge more than one million gallons per day (1 MGD). Five of the major facilities discharge directly to the Haw River. Other waterbodies receiving discharge from major WWTPs include South Buffalo, Moadams (Latham Lake), Big Alamance, Morgan, and New Hope creeks. The City of Greensboro's (NC0047384) T.Z. Osborne WWTP has the highest permitted as-built in the entire basin, and fourth highest in the state (56 MGD), discharging to South Buffalo Creek. Twenty-four of the minor permits are for small WWTP "package plants" (discharging 100% domestic waste, <1 MGD). Many of the

smaller (minor) facilities do not have the same monitoring or reporting requirements as larger facilities. All facilities, however, are inspected on a routine basis by DWR regional office personnel. Dischargers in the Jordan Lake watershed must comply with the Jordan Lake Nutrient Strategy point source rules. For more information see section 6.6.6.9 (B. Everett Jordan Lake – New Hope River Watershed Summary) below and the NPDES permitting strategy in Chapter 3, section 3.1.4.

The Haw River subbasin also accounts for close to 30% (6,218 acres) of the total field acres (21,771 acres) permitted for the non-discharge and residual land application programs, which is the highest percent in the basin. Permitted fields are primarily used for reclaimed water in the lower part of the subbasin and land application of residual solids in the middle and upper parts of the subbasin. The City of Burlington (WQ0000520) has the highest number of permitted field acres in the Haw River subbasin and second highest in the entire basin with 1,063 acres used for the land application of residual solids.

Numerous single-family wastewater systems are permitted under the NPDES wastewater discharge and non-discharge programs in the lower part of the Haw River subbasin near Jordan Lake in Chatham, Durham, and Orange counties where the Triassic Basin Level IV and Carolina Slate Belt ecoregions are located (*Figure 6-10*). In this region within the Haw River subbasin there are 209 NPDES single-family domestic wastewater discharge and 222 non-discharge single-family residence wastewater irrigation minor permits (*Table 6-9*). An overall basin map is also available for these single-family permit locations in Chapter 3, section 3.2.

Fewer AFOs are in the Haw River subbasin compared to subbasins located in the lower part of the basin. As of May 2022, permitted AFOs include 12 state cattle COCs (certificate of coverage), four swine state COCs and seven individual state permits. Overall basin maps and summary tables are available in Chapter 1, section 1.5.1, Chapter 1 appendix and permit maps and tables in Chapter 3, section 3.6.

Half (16) of the 32 NPDES MS4 stormwater permits in the Cape Fear River Basin are in the Haw River subbasin. NPDES MS4 permits are required for every owner/operator of facilities in areas that the US Census Bureau has designated as an Urbanized Area (see Chapter 3). MS4 stormwater permits are held by Apex, Burlington, Carrboro, Cary, Chapel Hill, Durham, Elon, Gibsonville, Graham, Greensboro, Haw River, Kernersville, Mebane, Morrisville, Swepsonville, and the University of North Carolina Chapel Hill.

See Chapter 3 and its Appendix for more information on permitting programs and permitted facilities within the Cape Fear River Basin.

Table 6-9: Total Number of Permits Found in the Haw River Subbasin

Number of Permits <sup>1</sup>		Permit Information <sup>1</sup>	
<b>NPDES Wastewater Discharge<sup>2</sup></b>			
<b>Major</b>	<b>Minor</b>	<b>Permitted As-Built (MGD)</b>	
11	54	146.73	
<b>Single-Family Domestic Wastewater Discharge</b>			
<b>Number of Permits</b>		<b>Permitted As-Built (MGD)</b>	
209		0.06	
<b>Non-Discharge and Land Application<sup>3</sup></b>			
<b>Major</b>	<b>Minor</b>	<b>Field Number</b>	<b>Field Acres</b>
21	33	671	6,218.3
<b>Single-Family Residence Wastewater Irrigation</b>			
<b>Number of Permits</b>		<b>Field Number</b>	<b>Field Acres</b>
222		223	70.0
<b>Stormwater</b>			
<b>State</b>	<b>NPDES</b>	<b>NPDES Outfalls</b>	
49	202	431	
<b>Animal Feeding Operations</b>			
<b>Number of Permits</b>		<b>Allowable Headcount</b>	<b>Allowable Weight (lbs)</b>
23		10,057	6,004,810

<sup>1</sup> Active and expired permitted facilities and associated permit data were queried from the DWR Basinwide Information Management System (BIMS) in May 2022. All permits are associated with active facilities.

<sup>2</sup> Permitted NPDES Discharge facility numbers are based on the number of facilities and as-built totals that discharge to the Cape Fear River Basin with the exception of NC0088692, which is located in the Haw subbasin and discharges to the Roanoke River Basin and not included.

<sup>3</sup> Some permitted fields are associated with facilities located outside of the Cape Fear River Basin.

Figure 6-9: NPDES Wastewater, NPDES Non-Discharge, NPDES Stormwater, and Animal Operations Permits in the Haw River Subbasin.

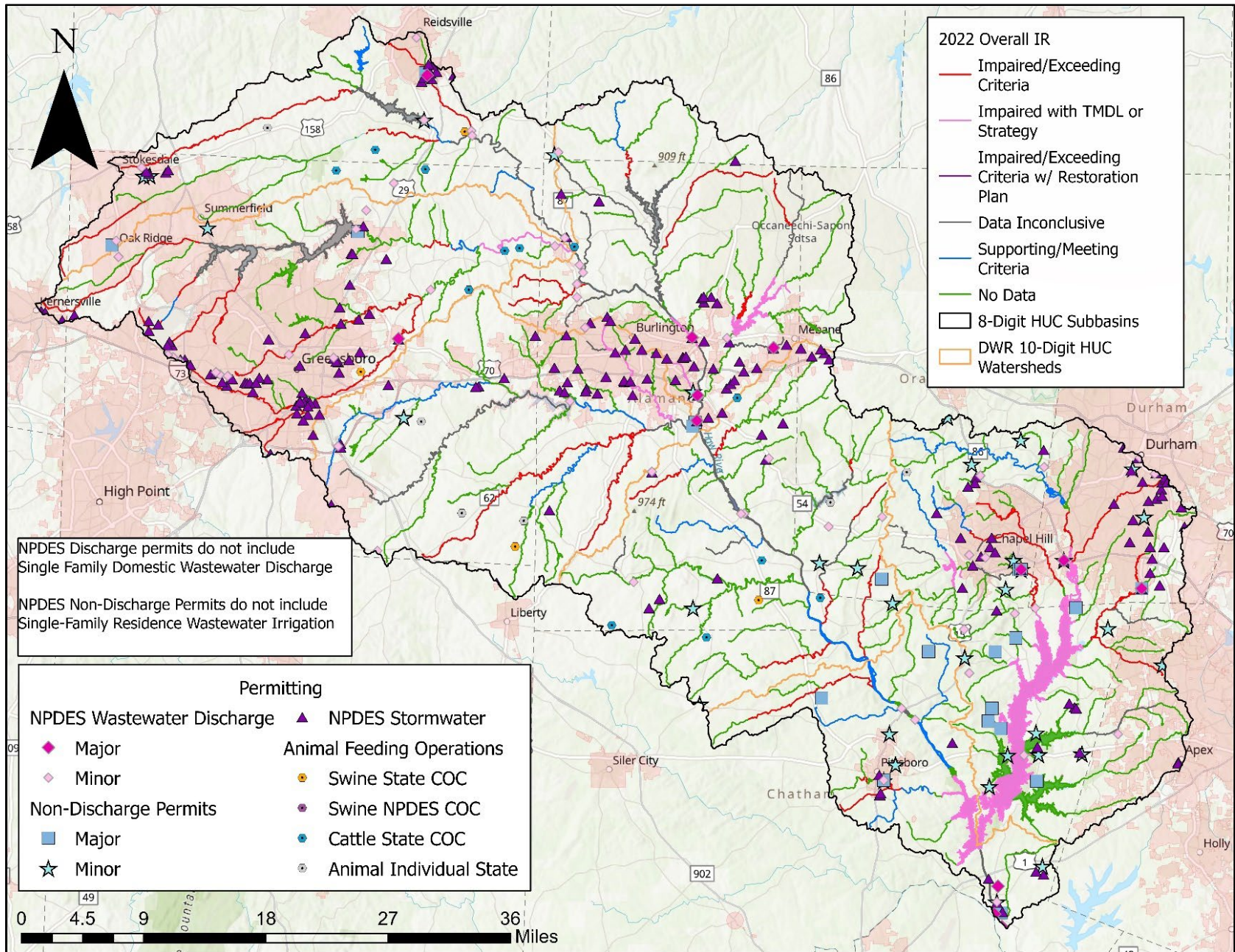
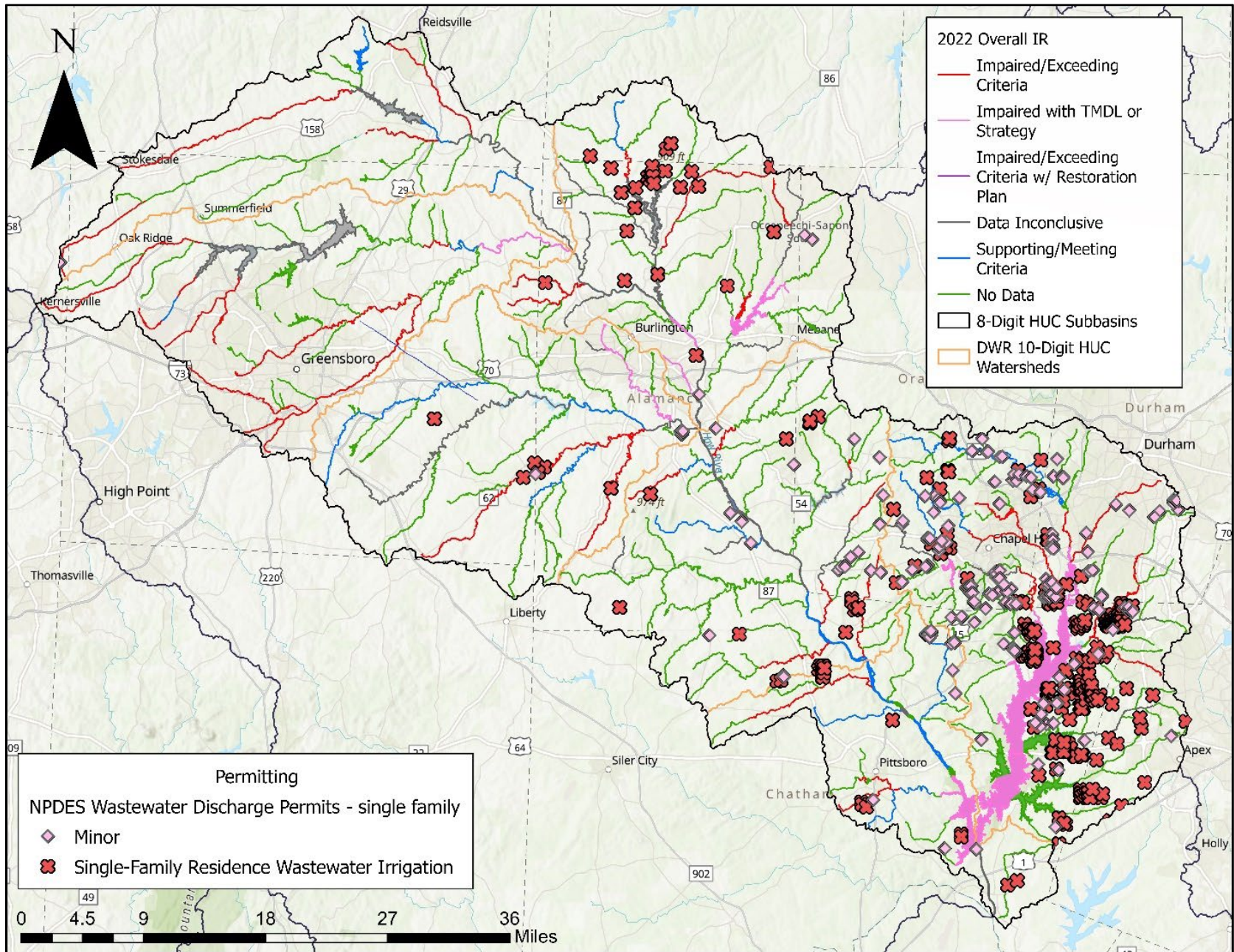


Figure 6-10: Single-Family Permits for NPDES Wastewater Discharge and Non-Discharge Residence Wastewater Irrigation



## 6.2 Biological Health

Biological communities are highly sensitive to changes in water quality and can reflect both long- and short-term environmental conditions. Benthos and fish community survey information is collected on species richness (i.e., diversity), abundance and composition, as well as site-specific conditions, such as stream habitat, physical water quality parameters, stream width and flow regime. Survey results and the presence of pollution tolerant and/or intolerant benthos species are used to calculate an Index of Biotic Integrity (IBI) score. Fish community IBIs evaluate the effects of all classes of factors that influence the fish community (e.g., water quality, energy source, habitat quality, flow regime and biotic interactions). Therefore, not all changes in the fish community are related to water quality. Fish community scores are a measure of the ecological health of the waterbody and may not directly correlate to water quality like benthic scores. IBI scores are assigned a descriptive rating, or bioclassification, of Excellent, Good, Good-Fair, Fair, Poor, Not Rated or Not Impaired. An “EPT” Biotic Index (BI) can also be used to assign ratings by using pollution sensitive species of mayflies (*Ephemeroptera*), stoneflies (*Plecoptera*), and caddisflies (*Trichoptera*). Benthic biocriteria, bioclassification assignment and [sampling methodology](#) can vary with region and stream conditions. In the Haw River subbasin, two assessment methodologies were used: Full Scale and EPT. See the [Benthic Standard Operating Procedures \(SOP\)](#) or the [Fish Community SOP](#) available through the DWR Water Sciences Section (WSS) for more information on biological monitoring and bioclassification ratings. More information on basinwide biology sampling is also available in Chapter 2.

The [Biological Assessment Branch](#) monitors each basin on a rotating five-year cycle. Basin monitoring locations are often re-visited during each cycle. Additional locations, called special study sites, may be monitored once or multiple times and are assessed during the monitoring cycle year and/or between cycle years. The basin monitoring cycle years covered in this plan were completed in 2008, 2013 and 2018. Biological monitoring occurred in 2023 as well but will not be included in this plan’s update. The results of the previous monitoring cycle, completed in 2003, was evaluated as a point of comparison. Maps in [Figure 6-11](#), [Figure 6-12](#), and [Figure 6-13](#) display all of the Haw River’s current benthic and fish community site ratings. Most of the poor rated biology sites were in the urban settings of Greensboro (along North and South Buffalo Creeks, Horsepen Creek and an unnamed tributary (UT) to Horsepen Creek at Guilford College) and in and around Burlington (along Big Alamance Creek and Travis Creek and its tributary, Tickle Creek).

Figure 6-11: Biological community monitoring stations for benthos and fish in the Haw River subbasin

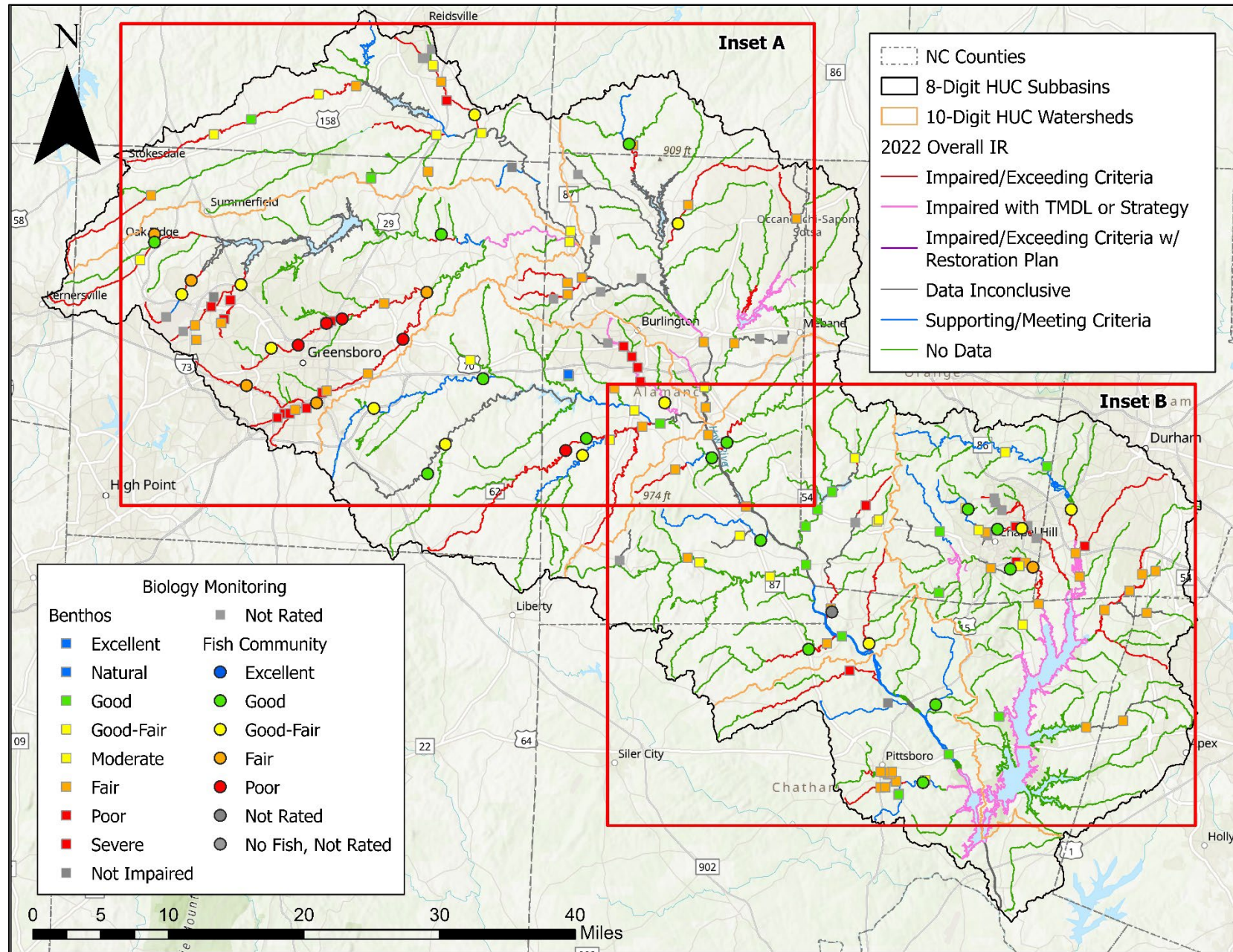
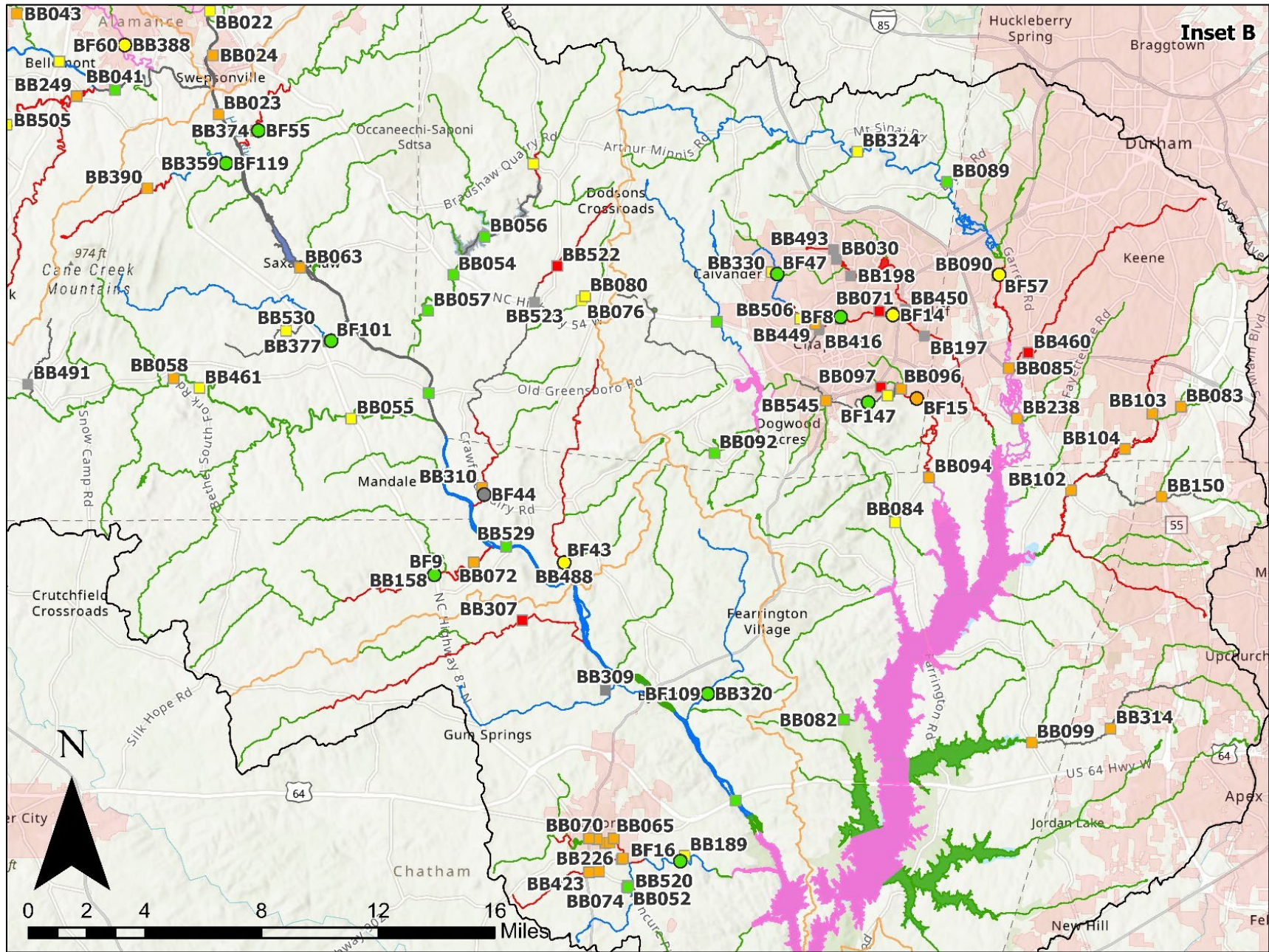




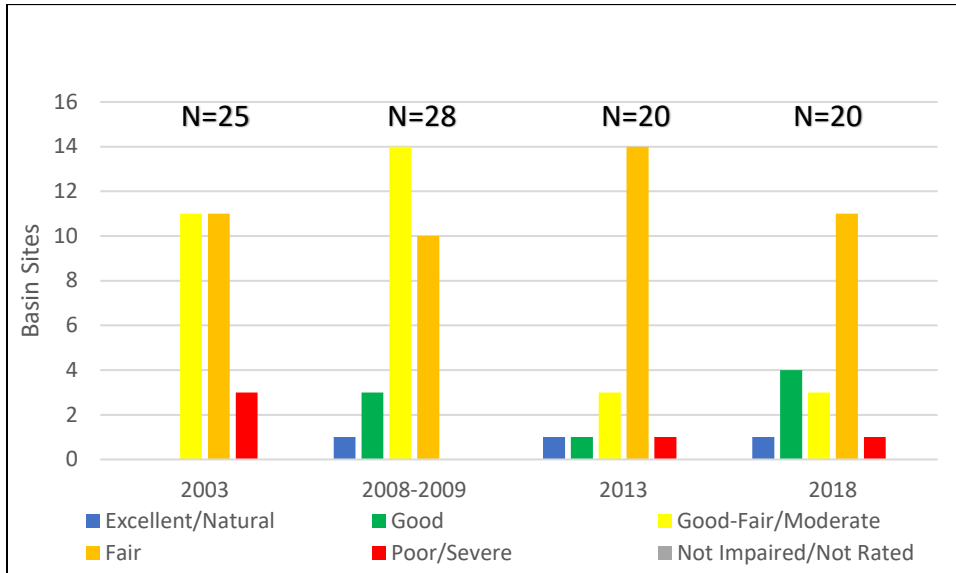
Figure 6-13: Biological community monitoring stations for benthos and fish in the Haw River subbasin Inset B



### 6.2.1 Benthic Macroinvertebrates

The Haw River benthos monitoring results for the four-cycle years are displayed in *Figure 6-14*. Basin site monitoring results for 2009 were also combined with 2008 as some stations were sampled (or resampled) in 2009 due to drought in 2008. Moderate results were more common during the first two sample cycles as compared to the last two cycles when Fair ratings were the most common. Additionally, more sites were sampled during the first two cycle years than in comparison with the last two (*Figure 6-14*). All benthos station results from 2002 to 2021 are available in the Appendix for Chapter 2.

*Figure 6-14: Haw River Benthos Bioclassification Ratings 2003, 2008-2009, 2013 and 2018 for Basin Sites*



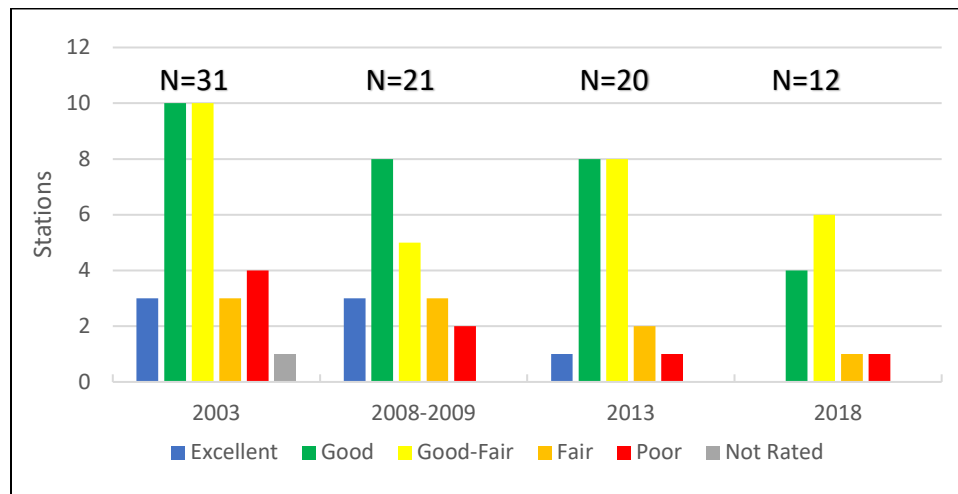
There is some variability in the basin monitoring sites chosen for monitoring cycle years 2003, 2008-2009, 2013, 2018 in *Figure 6-14*.

Graph data contains one station result per cycle year for 2003, 2013, 2018 and one station result for combined years 2008-2009. Where applicable, the most recent result for stations sampled >1 time per year(s) OR the most common result for stations sampled >2 times per year(s) was used.

### 6.2.2 Fish Communities

The Haw River fish community monitoring results for the four-cycle years and 2004 and 2009 are displayed in *Figure 6-15*. Monitoring results for 2003-2004 and 2008-2009 were combined for data used in the graphics as monitoring was not completed during regular cycle years. Fewer fish community stations were sampled during the last cycle in comparison to the first. Additionally, there were no excellent results and a smaller percent of good results in 2018 (*Figure 6-15*). All fish community station results from 2002 to 2021 are available in the Appendix for Chapter 2.

Figure 6-15: Haw River Fish Community Bioclassification Ratings 2003-2004, 2008-2009, 2013 and 2018



There is some variability in the basin monitoring sites chosen for monitoring cycle years 2003, 2008-2009, 2013, 2018 in *Figure 6-15*.  
 Graph data contains one station result per cycle year for 2013 and 2018 and one station result for combined years 2003-2004 and 2008-2009. Where applicable, the most recent result for stations sampled >1 time per year(s) OR the most common result for stations sampled >2 times per year(s) was used.

### 6.3 Ambient Water Quality

Monthly chemical and physical samples are taken by DWR through the Ambient Monitoring System (AMS) stations and Coalitions of NPDES permit holders that are active in the Cape Fear River Basin. In the Haw River subbasin all the coalition stations are monitored by the Upper Cape Fear River Basin Association (UCFRBA). Many of the ambient stations are associated with waterbody locations where potential pollution could occur from known land use activities in the subbasin. There are also portions of the subbasin where no water quality data are collected; therefore, water quality in those areas cannot be evaluated. Parameters collected depend on the waterbody classification, but typically include conductivity, dissolved oxygen, pH, temperature, turbidity, nutrients, and fecal coliform bacteria. Each classification has an associated set of standards the parameters must meet to be considered supporting the waterbody’s designated uses. Stressors are either chemical parameters or physical conditions that at certain levels prevent waterbodies from meeting the standards for their designated use.

The method used to identify an impaired waterbody for the IR is typically based on 10% exceedance rate of a standard and 90% percent confidence for a set of data generally collected over 5 years. The IR methodology also addresses less common situations such as small datasets (<10 samples) as can happen with lake and reservoir sampling. See Chapter 2 for information on the IR methodology and the ambient monitoring programs, including the Random Ambient Monitoring System (RAMS). It is important to note that fecal coliform results not collected using a 5-in-30 methodology are used for screening purposes only.

There are currently 22 AMS and 23 UCFRBA stations being monitored in the Haw River subbasin with four of the stations co-located for the AMS and UCFRBA programs (B0400000 and B2100000, B3039000 and B3900000) (*Table 6-11* and *Figure 6-16*). A complete list of all ambient monitoring stations from 2000 to

2020 is available in Chapter 2 Appendix. Ambient monitoring station sampling results are discussed in detail in Section 9.9.

An overall comparison of the Haw River's HUC10 watershed scale ambient water quality results for samples collected in the basin from 2016 to 2020 is shown in [Table 6-10](#). Mean results for pH, dissolved oxygen (DO), conductivity, nutrients, turbidity, Total Suspended Solids (TSS) and fecal coliform bacteria were determined for stations that had a minimum of five years and 40 average day records. [Table 6-10](#) also shows the HUC8 mean levels for these parameters from 2016 to 2020 in the Haw River subbasin, and for comparison purposes, the highest HUC8 and HUC10 mean levels basinwide for conductivity, nutrients, turbidity, TSS and fecal coliform. An overall HUC8 scale comparison of the Cape Fear River basin's six subbasins is available in Chapter 3. All of the HUC10 scale parameter means and the number of stations used in the analysis for Chapter 2 are available in the Appendix. At the HUC8 scale, the Haw River subbasin had the highest mean five-year results for turbidity, TSS, total nitrogen (TN), inorganic nitrogen, and nitrate+nitrite (NOx). The Haw River had the second-highest conductivity levels, behind the Northeast Cape Fear River subbasin (HUC8 03030007), which had two very high outlier stations influenced by saltwater. The Northeast Cape Fear subbasin (HUC8 03030007) had the highest mean five-year results for conductivity, fecal coliform, total phosphorus (TP), ammonia (NH<sub>3</sub>), and organic nitrogen, Total Kjeldahl Nitrogen (TKN) minus ammonia. TKN, ammonia, conductivity, TP and fecal coliform bacteria mean levels were relatively lower in the Haw River subbasin than the Northeast Cape Fear. The highest basinwide HUC10 values included in the [Table 6-10](#) are described in depth in their respective watershed chapters spanning chapters 6 through 11 of this report.

At the HUC10 scale, the B Everett Jordan Lake-New Hope watershed (0303000206) had the highest mean five-year levels for conductivity, turbidity and TSS levels ([Table 6-10](#)). Mean levels of 26.63 NTU for turbidity and 26.64 mg/L for TSS in the Jordan-New Hope watershed were the highest at the HUC10 scale basinwide. Reedy Fork (0303000201) had the highest mean HUC10 ammonia, NOx, TN, and TP levels; the Cane Creek-Haw watershed (0303000205) had the highest TKN levels; and Big Alamance Creek (0303000203) had the highest fecal coliform bacteria levels in the Haw River subbasin. The Reedy Fork watershed had the second highest HUC10 scale mean levels for NOx (2.53 mg/L) and TN (3.35 mg/L) in the basin, behind the Rocky River watershed (0303000305) in the Deep ([Table 6-10](#)).

To understand how water quantity and water quality begin to intersect, an analysis and a series of graphics were developed plotting water quality parameters based on the distribution of flow ([Table 6-11](#) and [Figure 6-17](#)). The USGS gage stations were paired together with surface water quality stations when the two stations were less than or equal to 3 miles away from each other and less than or equal to 10% drainage area difference. For this purpose, these stations are considered co-located ([Table 6-11](#) and [Figure 6-17](#)).

Figure 6-16: Ambient Monitoring System and Coalition Stations in the Haw River subbasin.

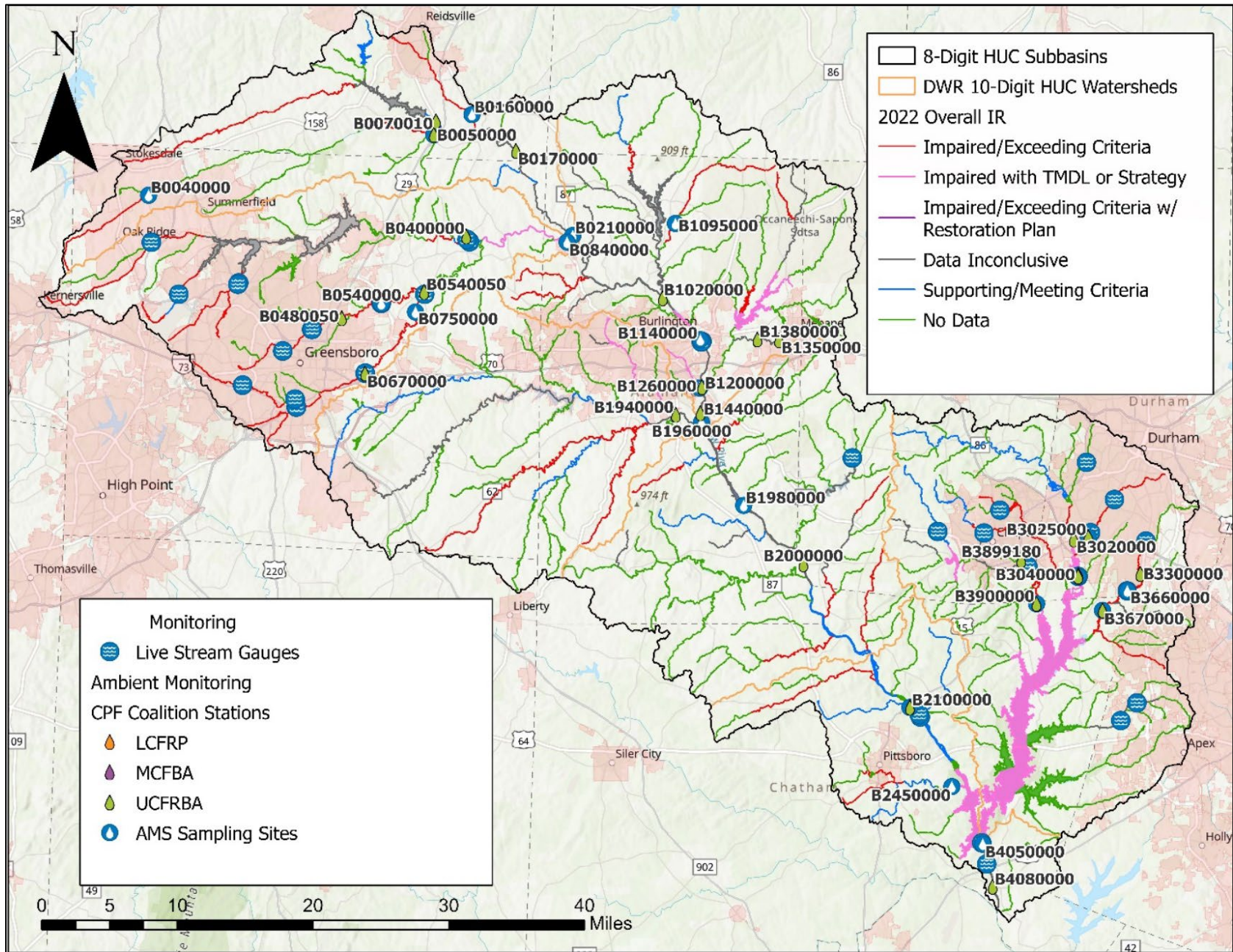


Table 6-10: Haw River Subbasin HUC10 Watershed Ambient Water Quality Means for 2016-2020

Watershed HUC 10	Watershed Name	Number of Stations <sup>^</sup>	pH	DO (mg/L)	Conductivity (μS/cm)	NH3 (mg/L)	TKN (mg/L)	NOx (mg/L)	TN (mg/L)	TP (mg/L)	Turbidity (NTU)	TSS (mg/L)	Fecal Coliform (cfu/100 mL)
Highest HUC 8 in Cape Fear River Basin		̄x			711	0.09	0.92	1.34	2.10	0.21	20.19	22.90	1,093
Highest HUC 10 in Cape Fear River Basin		̄x			1,413	0.27	1.44	2.62	3.48	0.38	26.63	26.64	2,478
<b>03030002*</b>	<b>HUC8 Haw River Watershed</b>	35	7.20	8.27	222	0.06	0.77	1.34	2.10	0.13	20.19	22.90	749
0303000201	Reedy Fork	7	7.23	8.47	270	0.10	0.84	2.53	3.35	0.19	12.92		947
0303000202	Headwaters Haw	6	6.95	8.30	110	0.04	0.58	0.40	0.98	0.06	20.76		429
0303000203	Big Alamance Creek	2	7.07	7.62	164	0.04	0.73	0.45	1.19	0.11	20.85		1,056
0303000204	Back Creek-Haw	8	7.31	8.57	248	0.07	0.84	1.39	2.23	0.16	21.38		983
0303000205	Cane Creek-Haw	2	7.38	9.01	217	0.04	0.89	1.23	2.12	0.11	23.61		848
0303000206	B Everett Jordan Lake-New Hope	6	7.11	7.52	275	0.05	0.75	1.45	2.19	0.14	26.63	26.64	732
0303000207	Roberson Creek-Haw*	7	7.41	8.61	176	0.05	0.82	0.80	1.61	0.09	17.27	15.85	313
Healthy Piedmont Stream <sup>#</sup>					12-90	0.05		0.30	0.80	0.05			
EPA Nutrient Criteria - Piedmont <sup>+</sup>									0.70	0.038			

<sup>^</sup>Ambient stations with a minimum of data collected for 5 years from 2016 to 2020 and 40 average day records were included in the analysis.

\*HUC10 Roberson Creek-Haw River watershed (0303000207) includes one Reservoir station and three River/Stream stations, all other stations in the HUC8 Haw River subbasin (03030002) are River/Stream stations.

<sup>#</sup>DWQ ESS- ISU Special Study. March 24, 2004, Rocky River Survey (Chatham County) Subbasin 03-06-12.

<sup>+</sup> USGS Circular #1350 – The Quality of Our Nation’s Water – Nutrients in the Nation’s Streams and Groundwater, 1992-2004. Dubrovsky et al., 2010.

Orange highlighted values represent the highest mean instream concentration or lowest DO concentration in comparison to the other HUC 10 watersheds.

Green highlighted row represents the overall HUC 8 watershed mean for each constituent for comparison purposes.

Average daily discharge (cfs) that matches the surface water quality data collected on the same day was used to calculate the water quality mean and median values for the different flow bins. The flow bins are based on the 25<sup>th</sup> and 75<sup>th</sup> percentiles (i.e.,  $\leq 25^{\text{th}}$  is low,  $\geq 75^{\text{th}}$  is high, in between is medium) calculated using 30 years of discharge data collected between 1991 and 2020 (the full flow record was used through 2020 if 30 years of data was not available for any given flow gage). (Table 6-11) The ambient water quality data available between 2002 and 2020 was used for this flow separated analysis at 11 stations throughout the Haw River Subbasin. The numbers on each bar of the graphs are the numbers of samples that fell into that flow assessment (Figure 6-17).

*Table 6-11: Haw River Watershed Water Quality (2002-2020) and USGS Co-located Flow Station Information Used for Flow Separated Analysis (Low Flow ( $\leq 25^{\text{th}}$  Percentile) and High Low ( $\geq 75^{\text{th}}$  Percentile) Statistics Included).*

Station ID	Station Location (Watershed Note)	Stream AU#	USGS Gage Station #	Flow Date Range	Low Flow $\leq 25^{\text{th}}$ (cfs)	High Flow $\geq 75^{\text{th}}$ (cfs)	Stream Class + NSW	HUC 12 03030 0020
B0400000	REEDY FORK AT SR 2719 HIGH ROCK RD NR MONTICELLO	16-11-(9)a3	02094500	1991-2020	9	58.20	WS-V	107
B0540000	NORTH BUFFALO CRK AT SR 2832 NR GREENSBORO (Downstream of old WWTP)	16-11-14-1b	02095500	1998-2020	19	43.4	WS-V	105
B0670000	SOUTH BUFFALO CRK AT SR 3000 MCCONNELL RD NR GREENSBORO	16-11-14-2a	02095000	1998-2020	6.43	28.7	WS-V	104
B1140000	HAW RIVER AT NC 49N AT HAW RIVER	16-(10.5)d	02096500	1991-2020	156	574	WS-V	408
B2100000	HAW RIVER AT SR 1713 NR BYNUM	16-(28.875)	02096960	1991-2020	242	1130	WS-IV	702
B3025000	THIRD FORK CREEK AT NC 54 NR DURHAM	16-41-1-12-(2)	02097280	2008-2020	1.36	12	WS-IV	602
B3040000	NEW HOPE CREEK AR SR 1107 NR BLANDS (Downstream of WWTP)	16-41-1-(11.5)c	02097314	1991-2020	18.2	89.3	WS-IV	604
B3660000	NORTHEAST CREEK AT SR 1100 NR NELSON (Downstream of WWTP)	16-41-1-17-(0.7)	0209741955	1991-2020	8.25	22	WS-IV	605
B3899180	MORGAN CREEK AT MASON FARM WWTP (Upstream of WWTP)	16-41-2-(5.5)a	02097517	1991-2020	14	36	WS-IV	607
B4050000	HAW RIVER BELOW JORDAN DAM NR MONCURE	16-(42)	02098206	2011-2020	394	2168	WS-IV	705
B4080000	HAW RIVER AT OLD US1 NR CAPE FEAR RIVER CONFLUENCE	16-(42)	02098206	2011-2020	394	2168	WS-IV	705

As expected, point sources (NPDES wastewater effluent discharge) influenced the instream concentrations of NO<sub>x</sub>, TP and conductivity more at base or low flows and nonpoint sources influence concentrations of fecal coliform bacteria, turbidity and TSS at high flows (Figure 6-17).

The stations downstream of wastewater treatment plants include B0540000 on North Buffalo Creek (downstream of the former North Buffalo WWTP), B3040000 on New Hope Creek (downstream South

Durham WRF) and B3660000 on Northeast Creek (downstream of Triangle WWTP). These three stations stand out on the NO<sub>x</sub> graph along with station B1140000 on the mainstem Haw River downstream of the confluence with Reed Fork, which is highly influenced by the Greensboro’s wastewater discharge (Figure 6-17). The stations not influenced by a major wastewater dischargers like B0400000 in the upper portion of Reedy Fork as well as the highly urbanized stations like B0670000 on South Buffalo in Greensboro and B3025000 on Third Fork Creek in Durham have much lower overall instream concentrations of NO<sub>x</sub> at any flow rate (Figure 6-17). Phosphorus is also influenced by wastewater discharge at these same stations.

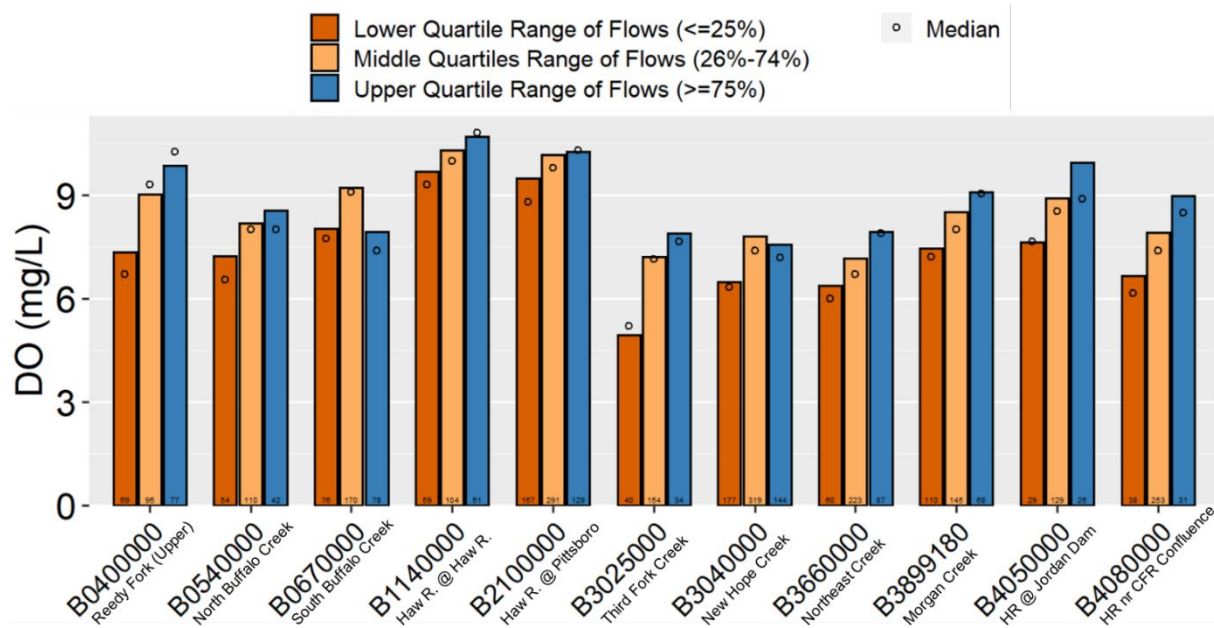
Ammonia concentrations were high at all three flow rates at B0540000, downstream of the old North Buffalo WWTP and just downstream of Jordan Lake Dam (Figure 6-17); more information include in the watershed discussion). TKN is fairly similar across all flows at most of the stations.

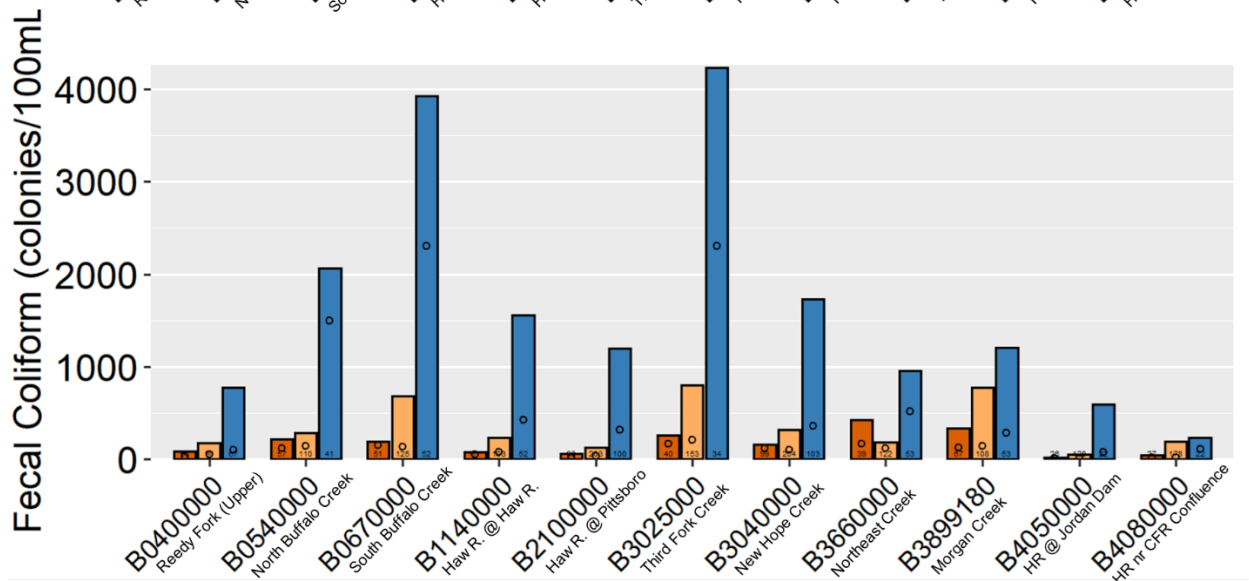
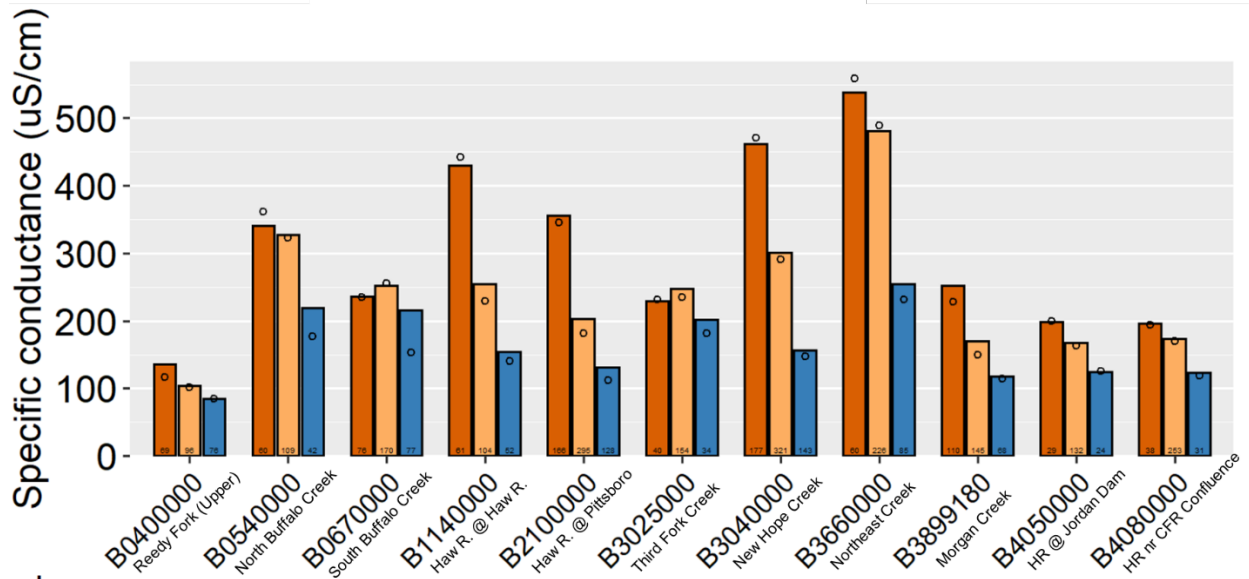
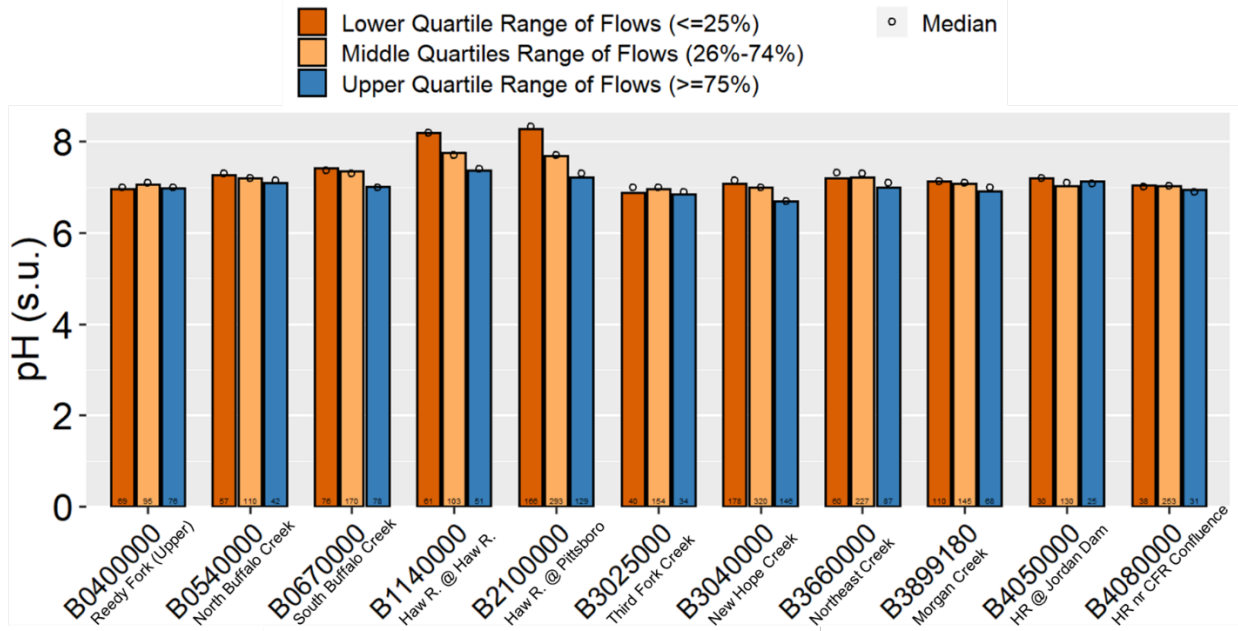
Fecal coliform bacteria is highest at high flows, especially at four of the urban sites, North and South Buffalo Creek in Greensboro and Third Fork and New Hope Creek in Durham. There are a few stations that have elevated concentration at normal flows (South Buffalo, Third Fork and Morgan creeks) and at B3660000 (Northeast Creek) the low flow had elevated concentrations (Figure 6-17). The TMDLs for fecal coliform bacteria throughout the Haw River watershed has identified urban sources during dry weather conditions as possibly including leaky sanitary sewer collection systems and straight pipes.

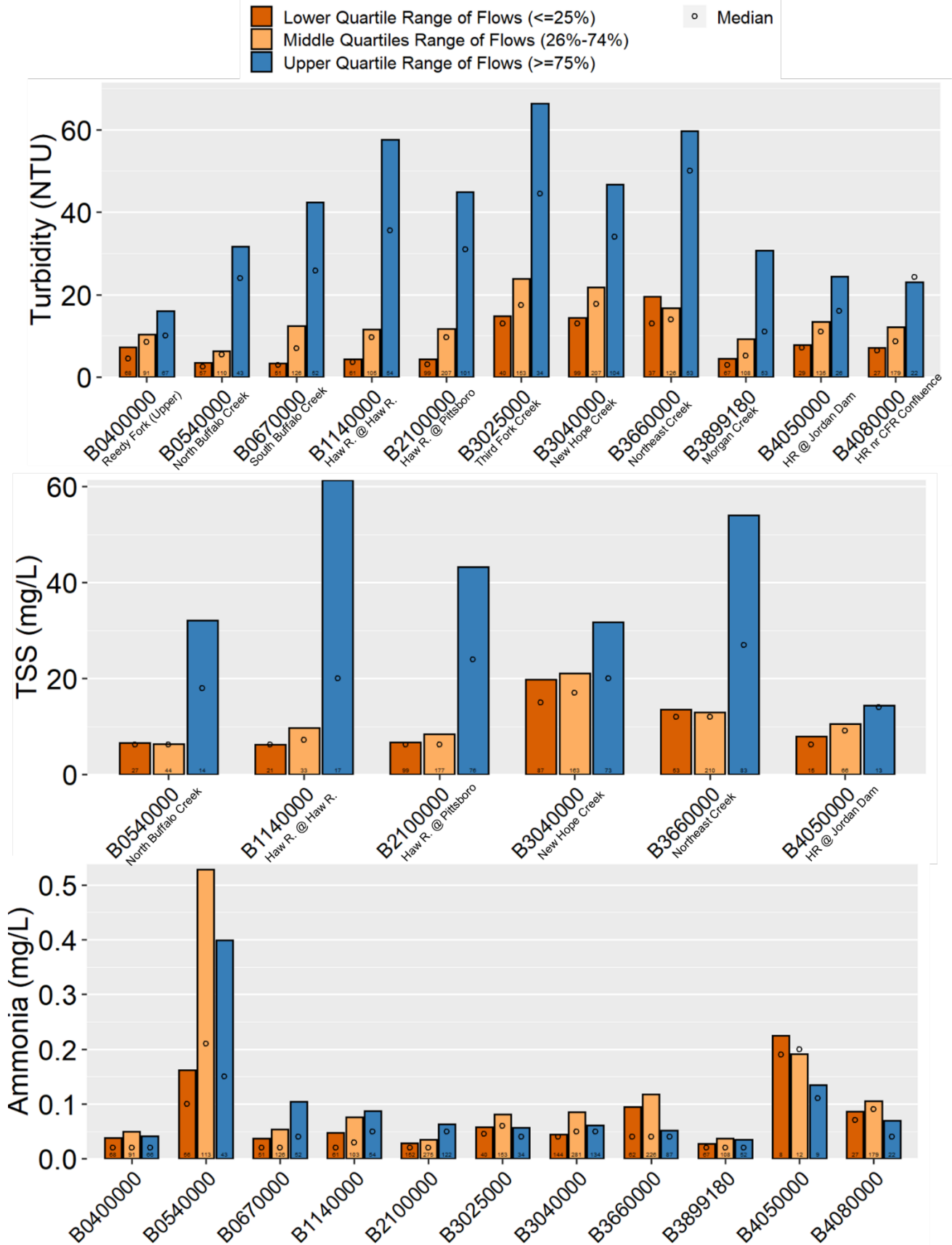
Turbidity and Total Suspended Solids (TSS) are obviously impacted by stormwater runoff and high instream volumes and velocities resulting in stream bank erosion (Figure 6-17). Dissolved Oxygen is generally a little higher at the two higher flow rates and pH is similar across flow rates and throughout the watershed.

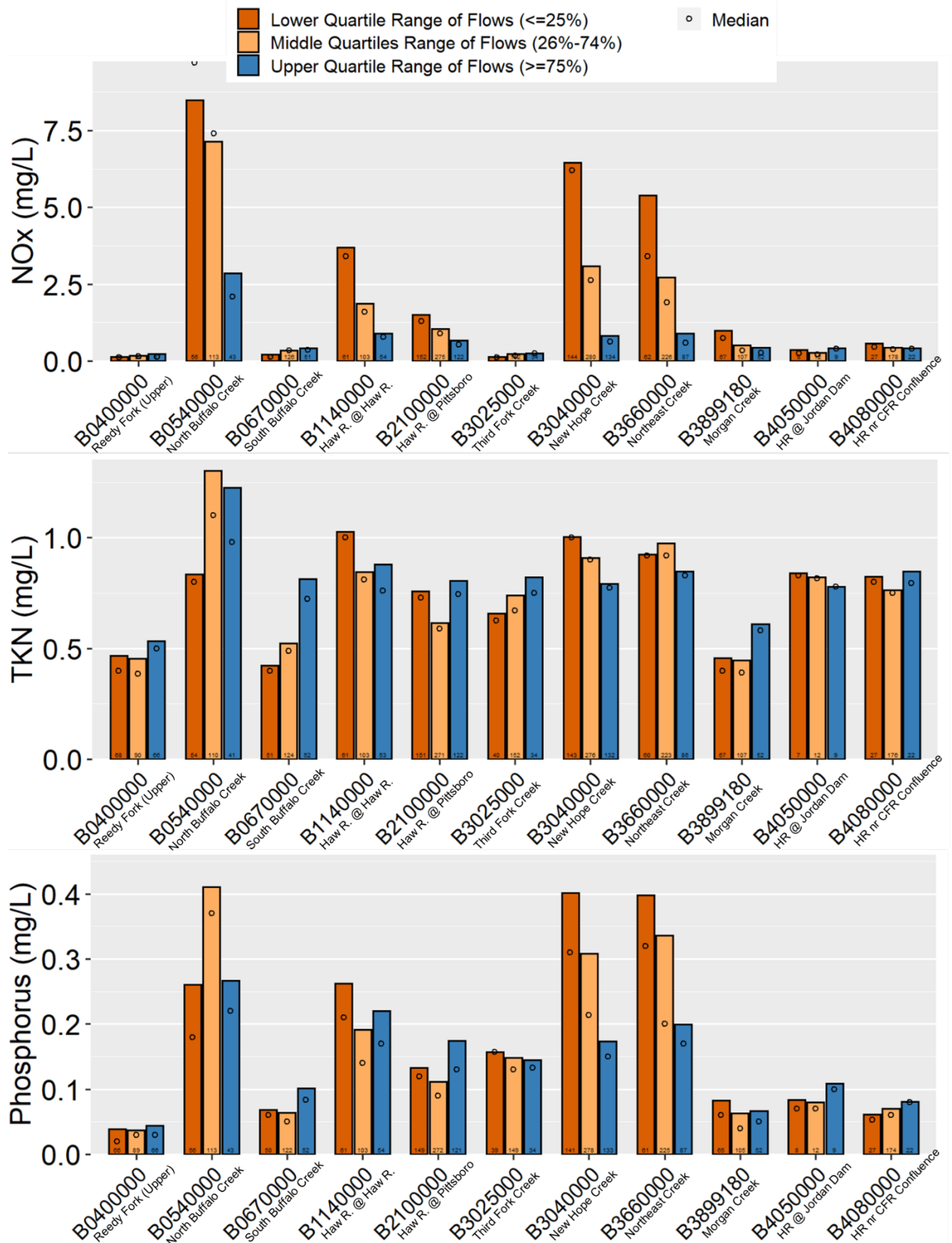
A more detailed discussion of the flow separated results will be presented in the watershed sections below when there is a specific impact to water quality.

Figure 6-17: Flow Separated Mean and Median Water Quality Concentrations at Co-located Ambient and USGS Gage Station for Data Collected between 2002-2020 in the Haw River Subbasin (03030002).









Emerging compounds (EC) are lesser known compounds that are increasingly being detected in soil, groundwater and surface water. They come from a wide range of sources, including industrial chemicals and their by-products, firefighting foams, pesticides, lawn and agricultural products, disinfection products, wood preservatives, home goods, as well as pharmaceutical and personal care products (PCPs) ([EPA, 2024](#)). In addition to industrial sources, these contaminants are often sent to landfills and wastewater treatment plants (WWTP) and subsequently discharged to surface waters. Many of these compounds do not readily biodegrade in the aquatic environment. Consequently, they often persist in water and are readily transported downstream because of a unique combination of physical and chemical properties that make them highly mobile and resistant to natural degradation.

In the last several years, emerging compounds have become the primary concern for the residents living in and receiving drinking water from the Cape Fear River Basin. Per- and polyfluoroalkyl substances (PFAS) and 1,4-dioxane are currently the primary contaminants of emerging concern in the Cape Fear River Basin due to their impact on human health in drinking water. The presence of these contaminants has been documented through sampling by university researchers, DEQ, the NC Collaboratory, public water and wastewater utility providers and other local and state entities.

After observing elevated concentrations of 1,4-dioxane [reported](#) as part of the EPA's Third Unregulated Contaminant Monitoring Rule ([UCMR3](#), 2013-2015), DWR initiated a study of 1,4-dioxane in surface waters of the Cape Fear River Basin (October 2014) with the objective of identifying potential sources, understanding changes in concentrations, and documenting data that will help the state develop a regulatory strategy. During the study, elevated levels of 1,4-dioxane were identified mainly downstream of the Greensboro, Reidsville and Asheboro WWTPs. DWR continues to work with these facilities to decrease the concentration of 1,4-dioxane in their discharges and requires effluent monitoring to ensure compliance with the CWA. DWR has also added ambient instream monitoring for 1,4-dioxane concentrations in areas where potential contamination might occur. Available instream 1,4-dioxane data is reported throughout the subbasin chapters. A 1,4-dioxane specific chapter (Chapter 13) with detailed Cape Fear River Basin studies and DEQ actions addressing the contaminant is included as part of the basin plan.

Researchers from North Carolina State University (NCSU) detected elevated levels of PFAS (including GenX) in the Cape Fear River in 2013-2015. The next year, DEQ, along with DHHS, began investigating PFAS in the basin to identify the potential source of contamination. The source of GenX was traced to Chemours in Bladen County along the west bank of the Cape Fear River in the Lower Cape Fear River subbasin. Other PFAS compounds, some of which are no longer manufactured, are being found in surface and ground water throughout the basin. The sources of these compounds into the Cape Fear River system are from contaminated wastewater, groundwater and atmospheric deposition.

Due to the changing nature of the science and due to the extent and magnitude of PFAS contaminants found in the Cape Fear River Basin as well as what corrective actions to take, PFAS was not discussed in detail within the subbasin chapters of this plan. A PFAS specific chapter was completed after finalizing the water quality and quantity watershed portions of the plan. The most up to date information on the extent of PFAS contamination within the Cape Fear River Basin, completed studies, and what actions have been taken by DEQ and EPA are summarized in the PFAS chapter (Chapter 12). DEQ is actively working to identify sources of PFAS and working to reduce the loading to the Cape Fear River system.

In response to the rising interest in the public health effects associated with per- and polyfluoroalkyl substances (PFAS), the Intensive Survey Branch (ISB) conducted a special study in 2023 alongside their

Ambient Lakes Monitoring Program (AMLMP) to characterize the presence and concentrations of PFAS compounds in public drinking water supply reservoirs of the Cape Fear River Basin. For five months between May and September 2023, ISB tested surface water samples for 47 different PFAS at Ambient Lakes Monitoring stations nearest to the surface water intake of 15 public water supply (PWS) reservoirs in the Cape Fear River Basin, eight of which are in the Haw River subbasin.

A total of 21 different PFAS compounds were found above the detectable laboratory practical quantitation limit (PQL) during the 2023 lakes monitoring study. At least one PFAS analyte was detected above the PQL in each reservoir during each sampling event. It is important to note that all analytical data reflect levels of target analytes detected in untreated surface waters, as opposed to finished drinking water. The results of this study are reported in detail in the PFAS Chapter of this plan (Chapter 12, Section 12.4.1.6).

The results demonstrated the widespread distribution of detectable PFAS in drinking water reservoirs in the Cape Fear River Basin. Additional long-term monitoring would be needed to evaluate the persistence of these compounds. The majority of the PWS facilities are taking part in the EPA Fifth Unregulated Contaminant Monitoring Rule (UCMR5) study, which requires PWS facilities to participate in monitoring for 29 different PFAS compounds in their finished drinking water. The results are reported to the State and EPA. The UCMR5 is discussed in detail section 12.4.2.4 of Chapter 12.

As science advances, laboratories are beginning to detect these compounds and researchers are discovering new details about their impacts. The science and research about emerging contaminants are quickly expanding, so DEQ has created a list of resources to help residents learn more. The latest information and updates can be found on the NC DEQ [Emerging Compounds](#) webpage.

#### 6.4 Haw River Watershed Action Plans

There are several approaches that DWR uses to restore and protect water resources in North Carolina that are generally referred to as watershed action plans (WAPs). WAPs rely on existing approaches such as total maximum daily load (TMDLs) or existing management strategies but includes voluntary restoration and protection approaches as well. The Cape Fear River Basin has one 4b demonstration plan for Little Alamance Creek. Little Alamance Creek, located in the Bowden Branch subbasin (HUC12 030300020309), was developed to address the biological integrity of benthic communities.

The TMDL Program is a federal program authorized under the Clean Water Act to address waters that are not meeting [water quality standards](#). A TMDL is a calculation of the maximum amount of a pollutant that a waterbody can receive and still meet water quality standards. The TMDL is then used to establish limits on sources of the pollutant that are classified as either point sources (waste load allocation) or nonpoint sources (load allocation). The TMDL must account for seasonal variation in water quality and include a margin of safety to ensure that the TMDL allocations will be adequate to protect the body of water. TMDLs have been completed in the Haw River subbasin for waterbodies listed in [Table 6-12](#).

More information on WAPs is available in Chapter 4 and on DWR's [Modeling and Assessment Branch website](#). Chapter 4 contains maps with the geographic boundaries of each individual parameter addressed by single or combined WAPs (TMDLs and voluntary restoration). In Addition, an interactive [map](#) is available for all of North Carolina's completed WAPs.

Table 6-12: Haw River Subbasin TMDLs

HUC 10 Watershed 0303000 +	Stream Name	Assessment Unit #	Parameter of Concern	Percent Reduction	Date Approved	Stream Length (mi/ac)	Classification + NSW	Old Subbasin #
201	Reedy Fork	16-11-(9)b	Fecal Coliform	77	7/9/2018	8.6	WS-V	03-06-02
	North Buffalo Creek	16-11-14-1b	Cyanide	*	9/16/1997	8.1	WS-V	03-06-02
	North Buffalo Creek	16-11-14-1a1, 16-11-14-1a2	Fecal Coliform	MS4-96; NPS-93	4/28/2004	8.7	WS-V	03-06-02
	South Buffalo Creek	16-11-14-2c	Fluoride, Cyanide, Selenium	*	9/16/1997	4.8	WS-V	03-06-02
202	Haw River	16-(10.5)b formerly # 16-(1)d1	Fecal Coliform, Turbidity	77 61	1/11/2005	1.3	WS-V	03-06-02
	Little Troublesome Creek	16-7-(1)b 16-7-(2)	Cyanide, Lead, Cadmium, Chromium, Total Residual Chlorine, Fluoride, Methylene-Blue-AS (MBAS)	*	9/16/1997	5.9	WS-V; WS-IV	03-06-01
	Little Troublesome Creek	16-7-(1)a, 16-7-(1)b, 16-7-(2)	Fecal Coliform	40	5/17/2002	9.5	WS-V; WS-V; WS-IV	03-06-01
203								
204	Haw River	16-(10.5)c, 16-(10.5)d, Formerly # 16-(1)d2, & 16-(1)d3 – Retired AU #s	Fecal Coliform, Turbidity	77 61	1/11/2005	1.3	WS-V	03-06-02
	Back Creek (Graham-Mebane Reservoir)	16-18-(1.5)a1, 16-18-(1.5)a2a, 16-18-(1.5)a2b, 16-18-(1.5)b	Total Phosphorus, Total Nitrogen	TN-8; TP-5	9/28/2010		WS-II, HQW, CA	03-06-02
	Town Branch	16-17	Fecal Coliform		9/16/2002		WS-V	03-06-02
205	Cane Creek (Cane Creek Reservoir)	16-27-(2.5)b	Total Phosphorus, Total Nitrogen	TN-8; TP-5	9/28/2010		WS-II, HQW, CA	03-06-04
206	Third Fork Creek	16-41-1-12-(2)	Turbidity	53	1/11/2005	3.6	WS-IV	03-06-05
	Jordan Lake	16-(37.3), 16-(37.5)a, 16-(37.5)b	Total Phosphorus, Total Nitrogen	TN-8; TP-5	9/20/2007		WS-IV, B, CA	03-06-04
	Jordan Lake	16-41-(0.5), 16-41-(3.5)a, 16-41-1-(14), 16-41-2-(9.5)	Total Phosphorus, Total Nitrogen	TN-35; TP-5	9/20/2007		WS-IV, CA	03-06-05
	Jordan Lake: Haw River area	16-(37.3), 16-(37.5)a, 16-(37.5)b,	High pH	TN-8; TP-5	4/3/2014		WS-IV, B, CA	03-06-04
	Jordan Lake: Morgan Creek Area	16-41-2-(9.5)	High pH	TN-35; TP-5	4/3/2014		WS-IV, CA	03-06-05
	Jordan Lake: Haw River area	16(37.3), 16-(37.5)a, 16-(37.5)b	Turbidity	TN-8; TP-5	4/3/2014		WS-IV, B, CA	03-06-04

HUC 10 Watershed 0303000 +	Stream Name	Assessment Unit #	Parameter of Concern	Percent Reduction	Date Approved	Stream Length (mi/ac)	Classification + NSW	Old Subbasin #
	Jordan Lake: Morgan Cr. area New Hope Cr. Area	16-41-1-(14), 16-41-2-(9.5)	Turbidity	TN-35; TP-5	4/3/2014		WS-IV, CA	03-06-05
	Morgan Creek (University Lake)	16-41-2-(1.5)	Total Phosphorus, Total Nitrogen	TN-35; TP-5	9/28/2010		WS-II, HQW, CA	03-06-06
	Northeast Creek	16-41-1-17-(0.7)a, 16-41-1-17-(0.7)b1, 16-41-1-17-(0.7)b2	Fecal Coliform	92-94	9/12/2003	7.4	WS-IV	03-06-05
207	Roberson Creek	16-38-(5), 16-(37.5)b	Total Phosphorus	71	1/13/2004	0.6	WS-IV, CA	03-06-04

\*TMDL reductions for the parameters of concern have been implemented through the addition of water quality-based effluent limitations in the affected NPDES permits in the watersheds listed. All of the associated dischargers have complied with the added NPDES permit limits. The NPDES permitting branch will continue to ensure compliance through their standard permitting practices and will add or modify limits and monitoring requirements where Reasonable Potential Analyses (RPAs) show they are necessary to maintain compliance with instream water quality standards for the protection of human health and aquatic life.

[TMDL Webpage](#)

## 6.5 Haw River Subbasin Watershed Plans

The first step to watershed restoration is to develop a watershed plan. A watershed plan is a strategy and a work plan for achieving water resource goals that provides assessment and management information in a watershed. The Haw River subbasin has eight EPA defined 9-element watershed plans that have been developed to address impaired waterbodies (*Table 6-13*). More information about watershed planning and 9-element plans can be found in Chapter 4.

*Table 6-13: Haw River Subbasin Watershed Plans*

HUC8	HUC12	Watershed Plan	Plan Year	Plan Developer(s)
03030002	0603	<a href="#">Bolin Creek Watershed Restoration Plan</a>	2012	Town of Chapel Hill, Town of Carrboro
03030002	0602	<a href="#">Durham Third Fork Creek Watershed Management Plan</a>	2012	City of Durham
03030002	0703	<a href="#">Robeson Creek Watershed Restoration Plan</a>	2013	Robeson Creek Watershed Council
03030002	0604, 0605	<a href="#">Northeast and Crooked Creek 9-Element Checklist</a>	2013	City of Durham
03030002	0404, 0303, 0302	<a href="#">Little Alamance, Travis and Tickle Creek 9-Element Checklist;</a> <a href="#">EEP Watershed Plan Phase III Report;</a> <a href="#">Fact Sheet</a>	2015 2008	Piedmont Triad Regional Council

HUC8	HUC12	Watershed Plan	Plan Year	Plan Developer(s)
03030002	0607, 0303	<a href="#">Morgan Creek and Little Creek 9-Element Plan Checklist</a>	2015	NC Ecosystem Enhancement Program, Triangle Council of Governments
03030002	0601, 0603, 0604	<a href="#">New Hope Creek &amp; Little Creek Watershed Improvement Plan</a>	2021	City of Durham
03030002	0701	<a href="#">Dry Creek Watershed Plan</a>	2023	Triangle J Council of Governments

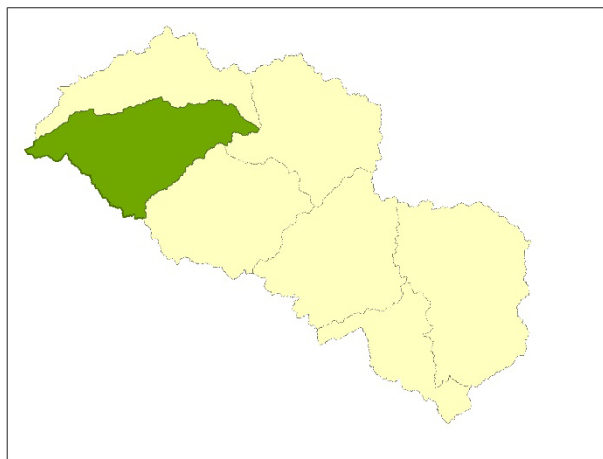
## 6.6 Water Quality on the Watershed Scale (HUC 10)

To determine the source of pollutants in a watershed, it is useful to evaluate them on a smaller scale. Smaller-scale evaluations can also help identify where monitoring and restoration is needed or being conducted. North Carolina assigns numbers to surface waterbodies. For water quality assessment purposes, these numbers are referred to as assessment unit numbers (AU#). A letter attached to the end of the AU# indicates that the assessment unit has been segmented, or broken into smaller pieces, to target the water quality assessment and the data associated with it. AU#s that have water quality data associated with them are discussed here on a watershed (HUC 10) scale. Not all stream segments are monitored by DWR. DWR does, however, value qualitative information from stakeholders throughout the basin to understand what is impacting water quality in a particular area. Information provided by stakeholders is incorporated into each watershed along with recommendations to protect and improve water resources in the watershed.

### 6.6.1 Reedy Fork Watershed (0303000201)

Includes: Reedy Fork, Brush Creek, Horsepen Creek, North Buffalo Creek, South Buffalo Creek & Buffalo Creek

The headwaters of Reedy Fork start in Kernersville and flow through the towns of Oak Ridge, Summerfield, Greensboro and into the Haw River near Ossipee. The Reedy Fork watershed is highly urbanized, with 47.2% of the area classified as developed (*Table 6-6*). The Reedy Fork watershed is located mostly within Guilford County, covering 255 square miles. The population increased by about 27,000 people between 2010 and 2020 for a total of 317,000 people (*Table 6-4*). Reedy Fork itself spans the northern portion of the watershed flowing through suburban areas around Lake Brandt and Lake Townsend and agricultural and forested land east of Lake Townsend.



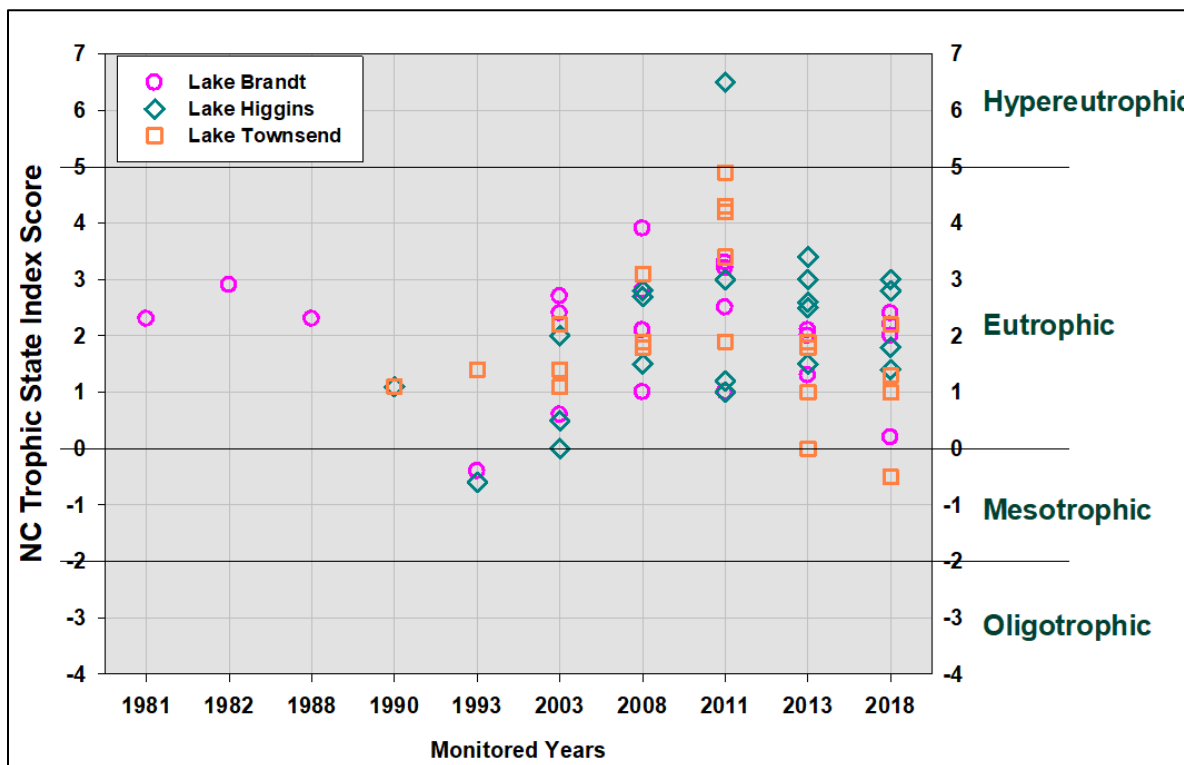
The upper portion of Reedy Fork and the streams that flow into it are classified WS-III (Water Supply Watershed III). This portion of Reedy Fork flows through Lake Higgins, Lake Brandt and Lake Townsend, the drinking water supply reservoirs for the City of Greensboro. These reservoirs are all classified as eutrophic (very biologically productive; *Figure 6-18*). Since this watershed drains to Jordan Lake, the rest of this watershed is classified as WS-V.

Within the watershed, North and South Buffalo creeks drain the majority of downtown Greensboro then join to form Buffalo Creek, which flows primarily through agricultural and forested land and finally joins Reedy Fork nine miles before the confluence with the Haw River.

For this assessment, there are seven ambient stream monitoring stations [including three AMS, plus four UCFRBA coalition (does not include two stations not reported on in the basin plan)], 19 benthic macroinvertebrate stations (including basin as well as special study sites) and 14 fish community stations used to assess the water quality conditions over this time period (2002-2020). Ambient (see *Table 6-14*) and biology stations discussed in this section were used in the 2022 IR. A complete list of all 2002 to 2020 stations may be found in the Chapter 2 Appendix.

As of 2022, there were one major and 12 minor NPDES wastewater discharge facilities permitted for 56.498 MGD, four AFOs permitted for 770 head count and 858,500 lbs live weight, 14 acres of non-discharge wastewater fields, and 61 NPDES and two state stormwater facilities. T.Z. Osborne WWTP (NC0047384) is currently the only major NPDES discharger in this watershed. AFO facilities include three state cattle and one state swine. The wastewater fields are associated with the Summerfield Shopping Center WWTF (WQ0013808).

*Figure 6-18: Reedy Fork Watershed Lake Trophic Status (NCTSI)*



Data from WSS/ISB Lakes Program, January 2020- yearly average (1980s and 1990s) or monthly lake NCTSI average (2000 to present) are presented.

Table 6-14: Reedy Fork Watershed (0303000201) Ambient Monitoring Stations collected by DWR and the Upper Cape Fear River Basin Association Monitoring Coalition.

Station ID	Station Location	Monitoring Program*	County	Stream AU#	Stream Classification + NSW	HUC 12
B0400000 <sup>^</sup>	REEDY FORK AT SR 2719 HIGH ROCK RD NR MONTICELLO	UCFRBA <sup>1</sup>	Guilford	16-11-(9)a3	WS-V	30300020107
B0480050	NORTH BUFFALO CRK AT N BUFFALO CRK WWTP INFLUENT CONDUIT PIER AT GREENSBORO	UCFRBA	Guilford	16-11-14-1a2	WS-V	30300020105
B0540000 <sup>^</sup>	NORTH BUFFALO CRK AT SR 2832 NR GREENSBORO (~3.8 stream miles downstream of old WWTP)	AMS	Guilford	16-11-14-1b	WS-V	30300020105
B0540050	NORTH BUFFALO CRK AT SR 2770 HUFFINE MILL RD NR MCLEANSVILLE (~8 stream miles downstream of old WWTP)	UCFRBA	Guilford	16-11-14-1b	WS-V	30300020105
B0670000 <sup>^</sup>	SOUTH BUFFALO CRK AT SR 3000 MCCONNELL RD NR GREENSBORO	UCFRBA	Guilford	16-11-14-2a	WS-V	30300020104
B0750000	SOUTH BUFFALO CRK AT SR 2821 AT MCLEANSVILLE ~2.6 stream miles downstream of WWTP)	AMS <sup>2</sup>	Guilford	16-11-14-2c	WS-V	30300020104
B0840000	REEDY FORK AT NC 87 AT OSSIPEE	AMS <sup>3</sup>	Alamance	16-11-(9)b	WS-V	30300020108
Monitoring Station Not Reported in Basin Plan						
B0410000	NORTH BUFFALO CRK AT W FRIENDLY AVE AT GREENSBORO	RAMS	Guilford	16-11-14-1a1	WS-V	30300020105
B0690000	SOUTH BUFFALO CRK AT OLD US 70 NR GREENSBORO	AMS <sup>4</sup>	Guilford	16-11-14-2b	WS-V	30300020104

<sup>^</sup> Water quality station co-located with USGS gage station.

Monitoring Program\*: AMS = DWR Ambient Monitoring System; UCFRBA = Upper Cape Fear River Basin Association; RAMS=Random Ambient Monitoring System.

<sup>1</sup>Co-located station for two years; <sup>2</sup>Co-located station for 11 years; <sup>3</sup>Co-located station for three years; <sup>4</sup>Short-term monitoring for 3 years.

There were previously two major and 10 minor wastewater dischargers in this watershed. The two major dischargers were North Buffalo WWTP (NC 0024352; 16 MGD) and T.Z. Osborne WWTP (NC0047384; 40 MGD) on South Buffalo Creek. In 2010, the City of Greensboro requested speculative limits from DWQ for a proposed consolidation of the North Buffalo WWTP into an expanded (from 40 MGD to 56 MGD) T.Z. Osborne WWTP. Speculative limits were developed in accordance with the Jordan Lake Nutrient Management Strategy ([15A NCAC 02B.0270](#)) for TN and TP loads with equivalent effluent concentration of 5.23 mg/L TN and 0.66 mg/L TP at the combined permitted flow of 56 MGD (December 2010 speculative limits letter). Consolidation will likely improve the water quality in North Buffalo Creek and improve the conditions in the lower portion of Reedy Fork based on the overall nutrient reductions occurring as result of the T.Z. Osborne treatment plan upgrade. Two schools were also connected to T.Z. Osborne and their Jordan Lake allocation transferred to the City of Greensboro ([Table 6-15](#), 2014 T.Z. Osborne NPDES permit). Compliance with the annual TN load limits was expected by Dec. 31, 2021.

Table 6-15: City of Greensboro combined TN & TP Permitted Jordan Lake Allocations (2014 NPDES permit).

Treatment Plants	Allocations - TN		Allocations - TP	
	TN at EOP (lbs/yr)	TN at Lake* (lbs/yr)	TP at EOP (lbs/yr)	TP at Lake* (lbs/yr)
T.Z Osborne	643,595	289,618	80,899	35,595
Northeast MS & HS (NC0038156)	1,351	608	205	90
McLeansville MS (NC0038172)	331	149	52	23
North Buffalo Creek (NC0024325)	245,996	110,689	30,889	13,591
<b>TOTAL Combined Allocation</b>	<b>891,272</b>	<b>401,072</b>	<b>112,044</b>	<b>49,299</b>

\*Transport factors: Nitrogen = 45% and Phosphorus = 44%; Delivered to EOP – End of Pipe load

North Buffalo Creek WWTP ceased discharging into North Buffalo Creek on Oct. 6, 2017. All of the City of Greensboro’s wastewater is now treated by the T.Z. Osborne WWTP (56 MGD), which can be seen by the increase discharge volume into South Buffalo Creek (Figure 6-19). The effluent total nitrogen and phosphorus concentrations from the two treatment plants can be seen in Figure 6-20 and Figure 6-22. The T.Z. Osborne expansion and upgrade as required to meet the Jordan Lake nutrient reduction requirements are now in effect (as of January 2021) and the treatment plant BNR (biological nutrient removal) upgrade was completed by August 2021. The TN and TP yearly loads since 2009 and the 2021 permitted load (red line) can be seen in Figure 6-22 and Figure 6-23. The treatment plant has discharged below their allotted phosphorus load and, as of 2021, reduced their TN load below their TN allocation of 891,272 lbs/yr to the system. The reduction in nitrogen loading should result in a significant decline in the instream nitrogen concentration in the receiving streams.

Figure 6-19: North Buffalo Creek and T.Z. Osborne WWTP Monthly Average Discharge Effluent Flow (MGD) (BIMS DMR query 6/10/2021).

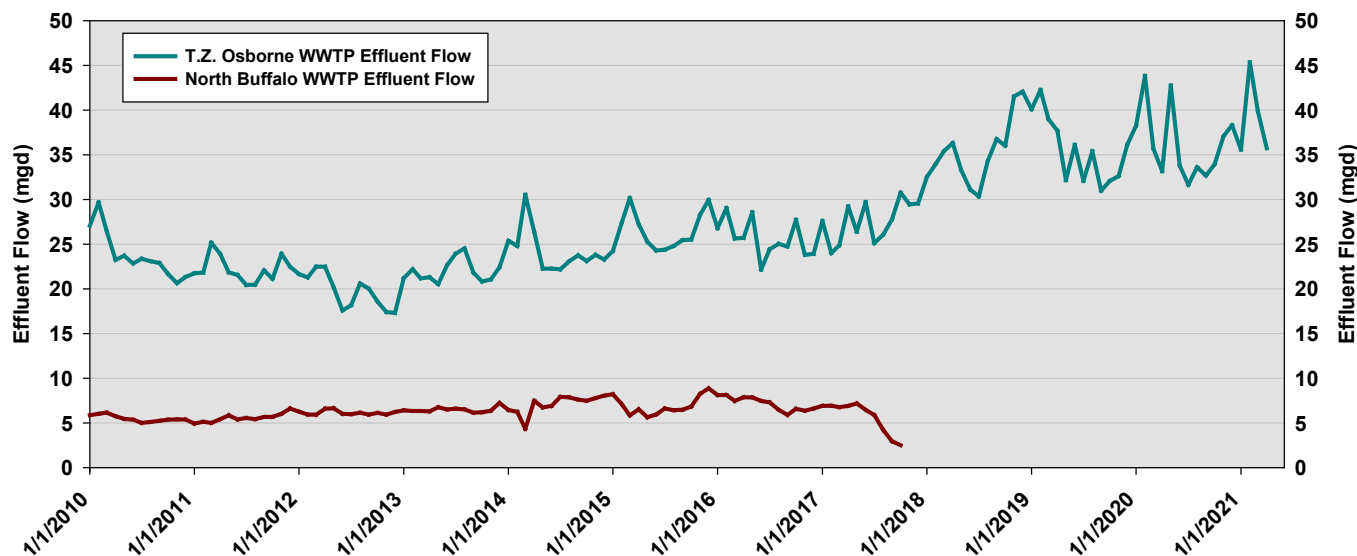


Figure 6-20: North Buffalo Creek and T.Z. Osborne WWTP Total Nitrogen Effluent Concentration (mg/L)  
(BIMS DMR query 6/10/2021).

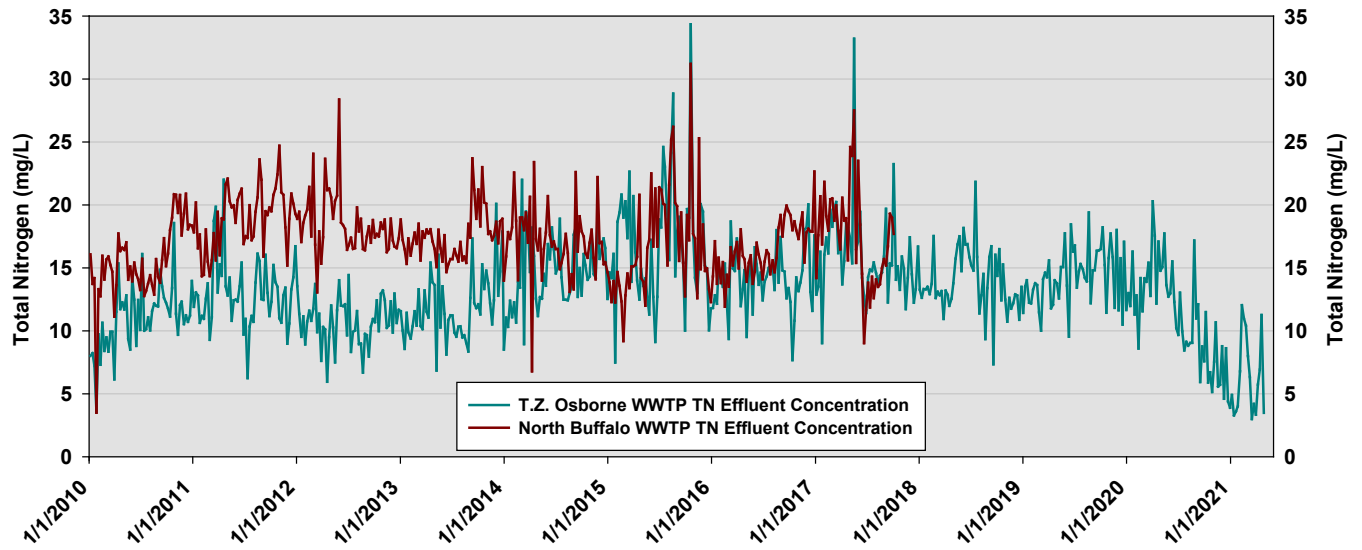


Figure 6-21: North Buffalo Creek and T.Z. Osborne WWTP Total Phosphorus Effluent Concentration (mg/L) (BIMS DMR pull 6/10/2021).

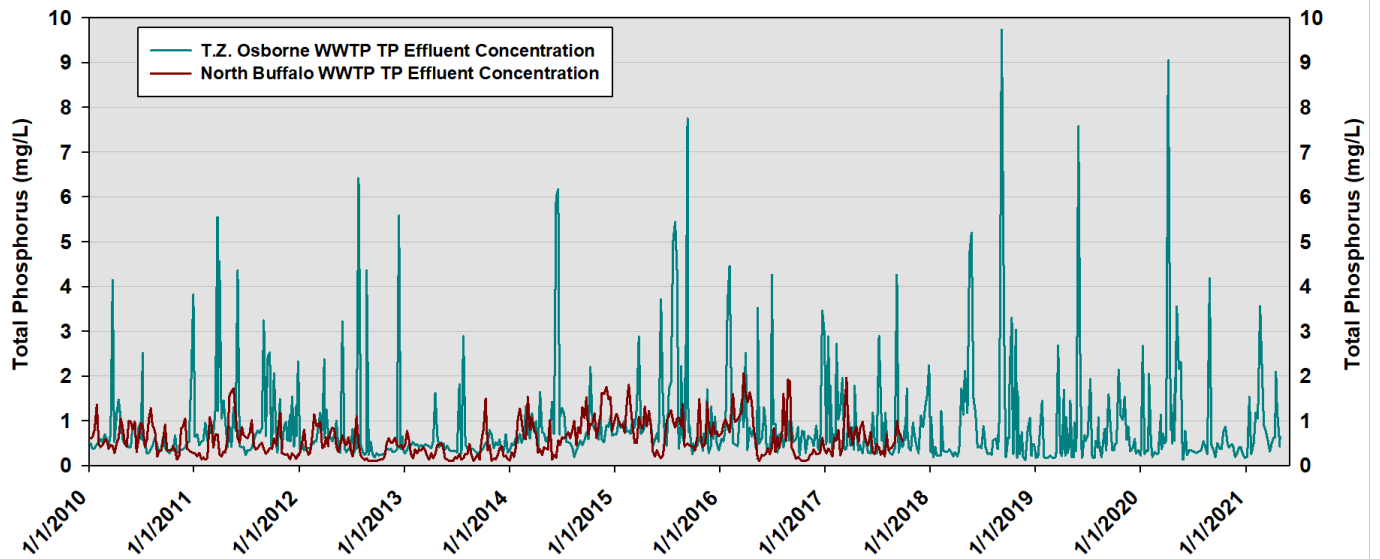


Figure 6-22: T.Z. Osborne WWTP Total Nitrogen Load (lbs/year) and Permitted Total Nitrogen Load Allocation as of 2021 (Red Line) (Data from NPDES May 2023).

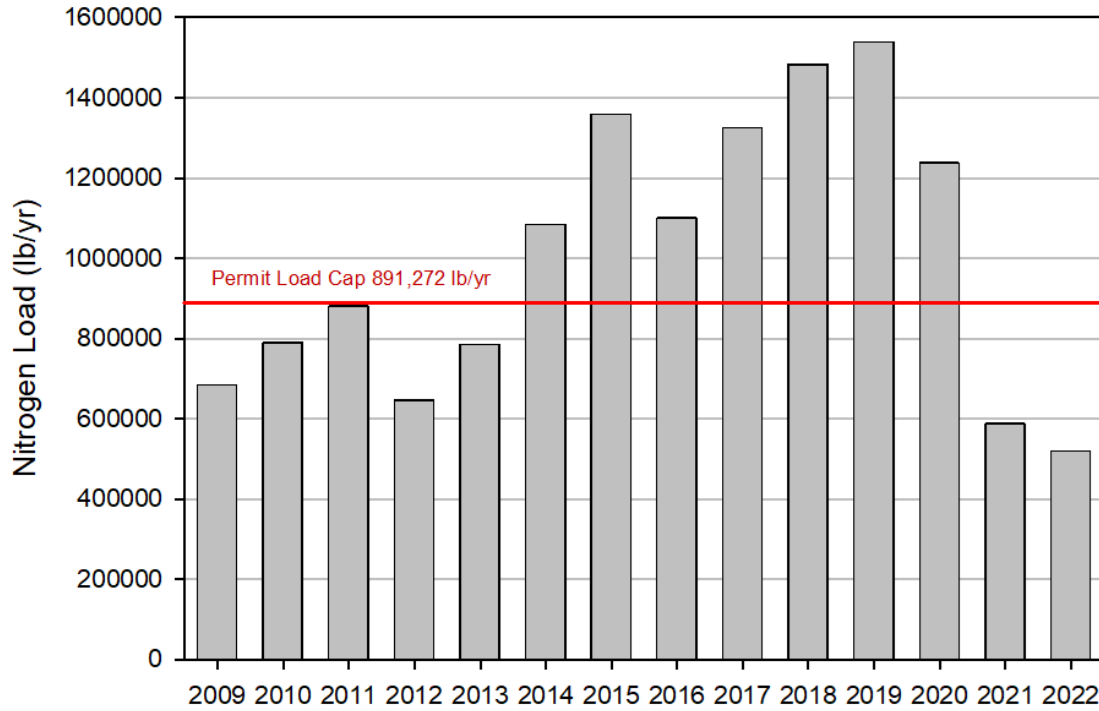
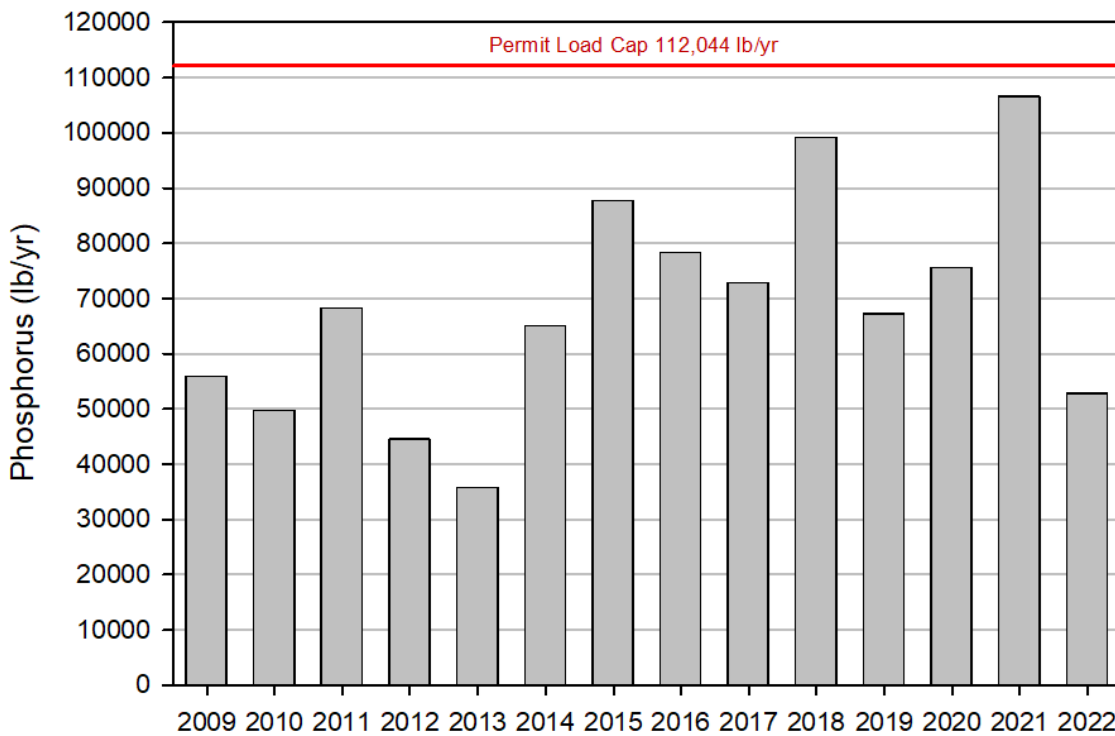


Figure 6-23: T.Z. Osborne WWTP Total Phosphorus Load (lbs/year) and Permitted Total Phosphorus Load Allocation as of 2021 (Red Line) (Data from NPDES May 2023).



The two major wastewater treatment plants appeared to contribute a large percentage of the nutrient concentration in their respective receiving streams (*Figure 6-24* and *Figure 6-25*; additional stream specific details can be found in the detailed stream write-up section below). The reduction in the TN and TP concentrations in North Buffalo Creek can be seen as the treatment plant ceased discharging to the stream in October 2017.

A DWR Cape Fear River study, identified elevated levels of 1,4-dioxane in surface waters downstream of the T.Z. Osborne Greensboro wastewater treatment plant (WWTP) (see Chapter 13 for details). 1,4-Dioxane can enter a publicly owned treatment works as a constituent of industrial, commercial and domestic wastewater. Treatment plants are generally not designed to remove 1,4-dioxane; therefore, it can pass through treatment systems and enter surface waters from treated effluent discharge. The T.Z. Osborne WWTP was identified as a contributor of 1,4-dioxane into the Haw River system impacting downstream water supply sources. In 2015, the City of Greensboro began a source identification and source reduction plan.

In March 2021, DEQ in collaboration with the City of Greensboro, entered into a Special Order by Consent (SOC) ([EMC SOC WQ S19-010](#)) to address issues related to the discharge of 1,4-dioxane from the T.Z. Osborne WWTP (NC0047384) to South Buffalo Creek. The SOC was subsequently amended and became effective in November 2021. The SOC had a three-year compliance schedule to meet specific concentrations in their effluent. The SOC required a daily 1,4-dioxane maximum concentration of 35 µg/L or less in the first year, 31.5 µg/L in the second year and 23 µg/L in the third year to protect downstream drinking water intakes (DEQ-EMC, 2021). The SOC included a requirement for the city to notify DWR and downstream users when violations of those concentrations were detected. The SOC also required that the City of Greensboro to provide an annual SOC report; all monitoring results and other important information on their website. As part of the SOC agreement, DWR provided semi-annual progress report updates to the Water Quality Committee of the EMC (Jan. 2024 [2<sup>nd</sup> Annual Progress Report](#)).

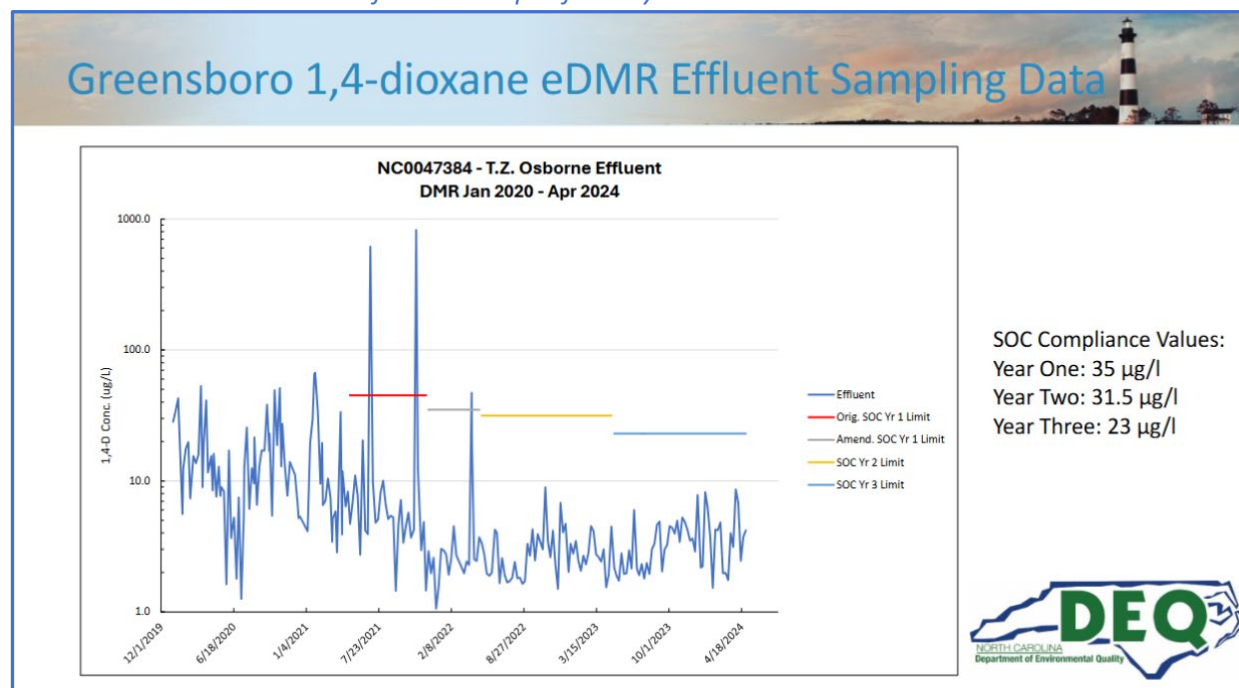
To help eliminate the risk of emergent contamination from SIUs, it is important that *Publicly Owned Treatment Works (POTWs) work with DWR to determine if their Pretreatment Program is sufficiently evaluating indirect dischargers to protect against accepting waste with potential emerging contaminants* (Jan. 2024 [2<sup>nd</sup> Annual Progress Report](#)).

Update to Greensboro's SOC information (February 2025).

The final Semi-Annual Progress Report on 1,4-dioxane in the Cape Fear River Basin was presented to the EMC Water Quality Committee (WQC) on July 10, 2024. Attached to the WQC agenda was:

1. The [Semi-Annual Progress Report](#) PowerPoint presentations to the WQC by DWR staff,
2. Attachment A - [Final Greensboro Settlement Agreement \(11-23-2021\)](#), and
3. Attachment B - [Greensboro SOC Year Three Report \(5-31-2024\)](#).

The conclusion reported to the WQC was that the SOC was effective and helped the City of Greensboro to identify Significant Industrial User (SIU) sources and took pretreatment actions to reduce 1,4-dioxane concentrations. Greensboro has not exceeded any of the SOC yearly compliance values since year one and continues to maintain the final limits specified in year three.



As of July 10, 2024, Greensboro was conducting post-SOC voluntary actions which include:

1. Continuing weekly effluent grab sample monitoring and will report within 24 hours to DEQ and notify downstream utilities if results are  $>23 \mu\text{g/L}$  (equal to SOC year 3 compliance value).
2. Will maintain their current pretreatment program mechanisms, modify permits as necessary, and require select SIUs to collect and retain daily samples.
3. Will continue to sample and monitor their system as well as other specific systems and locations throughout the watershed as previously done.

For more information, Greensboro maintains a website with their [1,4-dioxane updates](#).

There are two EPA approved fecal coliform bacteria TMDLs in the Reedy Fork watershed (upper North Buffalo Creek and lower Reedy Fork; *Table 6-12*).

Managing fecal coliform bacteria loads is a complex and difficult task, especially in urban watersheds containing a wide variety of potential sources. The upper North Buffalo Creek area is a highly residential

zone (38% residential land use; 2004 North Buffalo Creek TMDL). The primary sources identified in this urban watershed were pets, specifically dogs and cats during wet conditions and exfiltrating sanitary sewer collection systems during dry conditions.

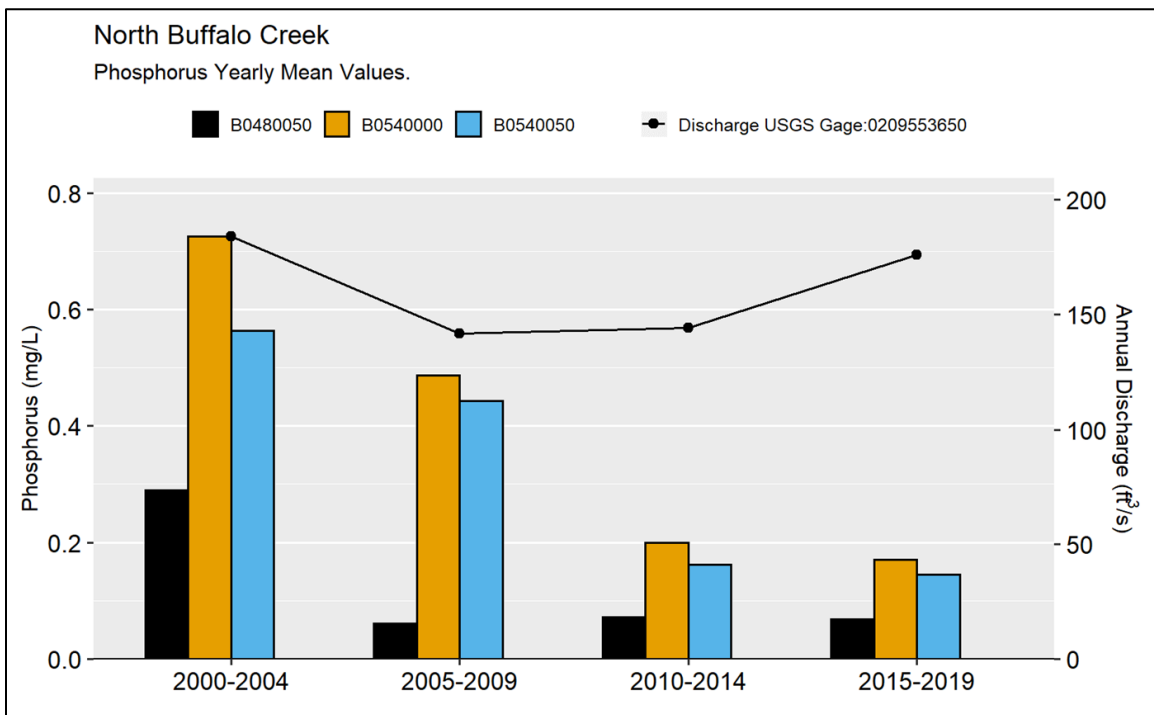
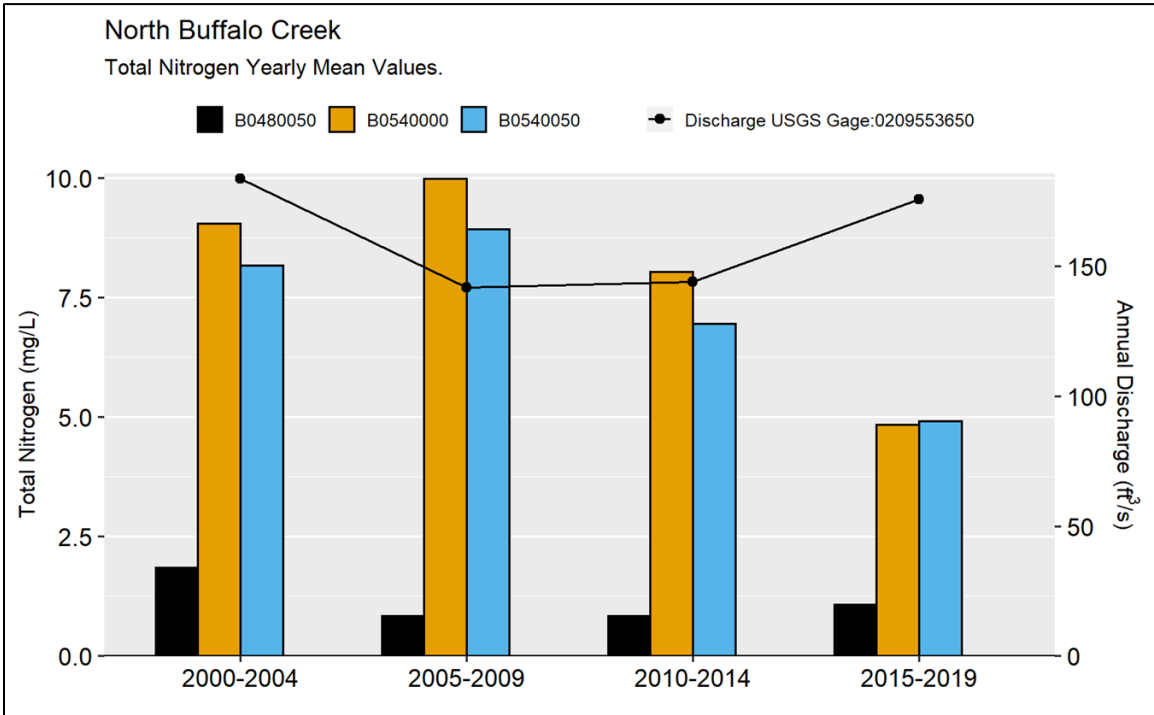
From a management perspective in an urban watershed, focusing resources on the control of dry weather loads should be the first step. Dry weather fecal coliform loads are often associated with human sources which are generally recognized as representing a greater risk of disease. The recreational use of North Buffalo Creek is generally higher during dry weather periods. North Buffalo Creek at Summit Avenue has been designated as the TMDL compliance point [the closest ambient monitoring station is about 1.3 miles downstream (UCFRBA station # B0480050)]. The percent load reduction necessary to meet TMDL requirements associated with the all weather conditions water quality target is 96% from MS4 sources and 93% from nonpoint sources ([2004 North Buffalo Creek TMDL](#)).

On July 9, 2018, the EPA approved the Reedy Fork Fecal Coliform TMDL (an addendum to the 2005 Haw River Fecal Coliform TMDL). Reedy Fork [AU# 16-11-(9)b] was not included in the original 2005 Haw River TMDL because it was not identified as impaired until the 2006 303(d) listing cycle. The 77% reduction in fecal coliform bacteria specified in the 2005 Haw River TMDL is expected to achieve the water quality standard in Reedy Fork ([2005 Haw River TMDL](#); [2018 Reedy Fork/Haw River TMDL Addendum](#); [NC DWR TMDL webpage](#)). The 2005 TMDL source assessment identified both point and nonpoint, urban and agricultural sources of bacteria.

Similar to the upper North Buffalo Creek study, instream fecal coliform bacteria violations occurred at both high and low flows, suggesting that contamination due to fecal coliform occurred during both wet and dry weather conditions. The results of the study indicated that the combination of collection system sewer pipe leaks, failing septic systems and direct illicit discharge likely elevated the fecal coliform bacteria concentrations during dry weather/low flow conditions. Correspondingly, nonpoint sources and sporadic sources such as sanitary sewer overflows had elevated the fecal coliform bacteria during high flows.

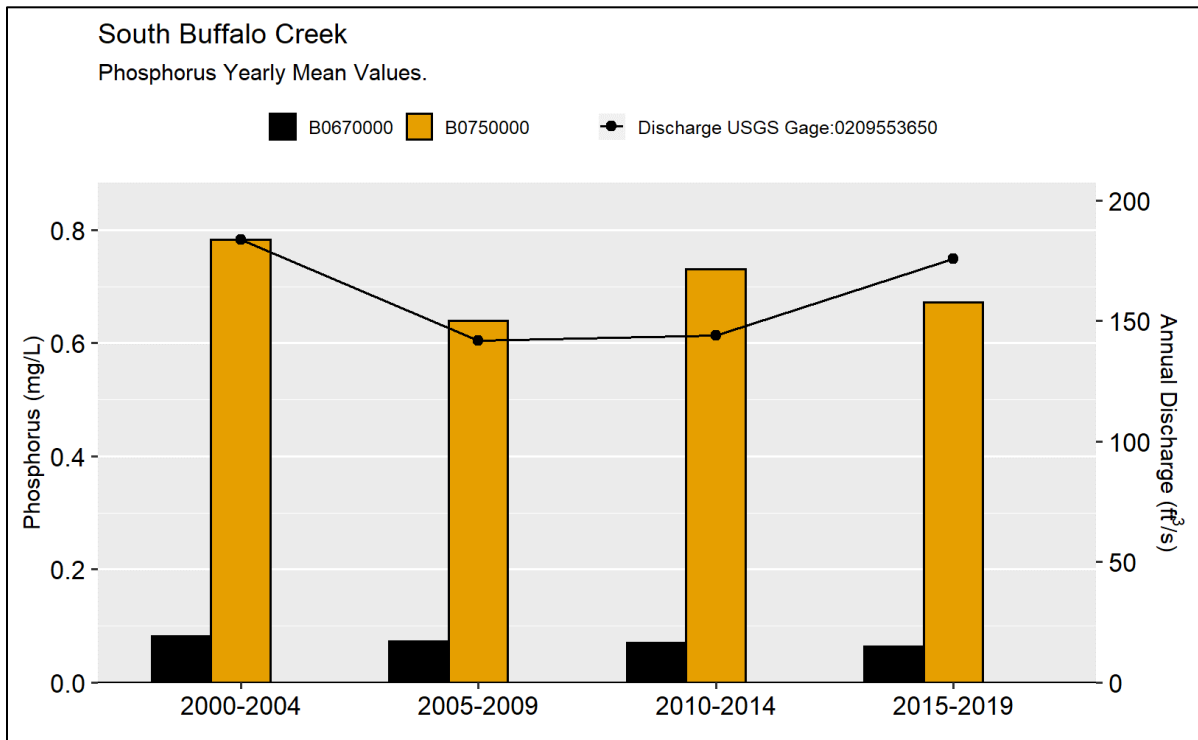
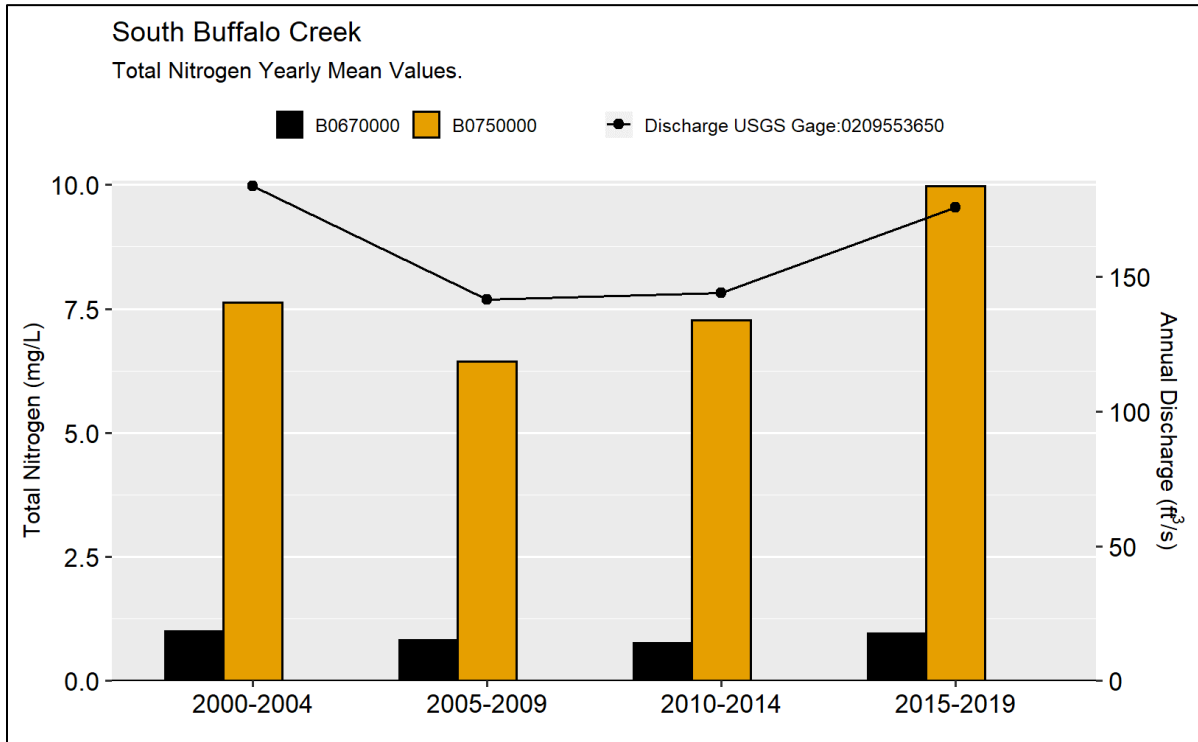
The City of Greensboro reported 44 Sanitary Sewer Overflows (SSOs) in 2020 and 42 in 2019 throughout their service area, mainly due to heavy rainfall or debris in the line ([City of Greensboro Water Resources 2020 Sewage Collection & water Reclamation Plant Report](#)).

Figure 6-24: North Buffalo Creek Instream Total Nitrogen and Total Phosphorus Five-Year Mean Concentrations (mg/L)



Ambient Monitoring Stations B0480050 (upstream of WWTP; black bar), B0540000 (downstream of WWTP; orange bar) and B0540050 (downstream of WWTP blue bar) with stream flow at USGS Gage Station 0209553650 (Buffalo Creek).  
 Note: North Buffalo Creek WWTP ceased discharging wastewater to North Buffalo Creek on October 6, 2017.

Figure 6-25: South Buffalo Creek Instream Total Nitrogen and Total Phosphorus Five-Year Mean Concentrations (mg/L)



Ambient Monitoring Stations B0670000 (upstream of WWTP; black bar) and B0750000 (downstream of WWTP; orange bar) with stream flow at USGS Gage Station 0209553650 (Buffalo Creek). Note: As of October 6, 2017, all of Greensboro's wastewater is treated at the T.Z. Osborne WWTP and discharged into South Buffalo Creek.

The City of Greensboro is implementing projects to limit or treat stormwater runoff, thus limiting the amount of fecal coliform entering North and South Buffalo Creeks. Information about Greensboro's initiatives can be found on their [Stormwater Programs and Projects website](#).

Greensboro's Department of Water Resources developed stormwater master plans for each of the major watersheds within its jurisdiction. The objective of each plan is to identify the major water quantity and quality issues within the watershed and outline structural and nonstructural BMPs to correct/minimize the identified problems ([Greensboro's stormwater program website](#)).

DWR will continue monitoring at ambient stations B0840000 (Reedy Fork) and B1140000 (Haw River) to provide a measure of progress towards meeting the TMDL goals. The most current available data for these two stations are below in the stream specific write-up.

The 2022 IR impaired streams in the Reedy Fork watershed (0303000201) are listed in [Table 6-16](#). The current (2022 IR) stream water quality conditions will be discussed in detail below.

Several stations were assessed in the Reedy Fork watershed as part of the 1,4-dioxane special study in the Cape Fear River basin. Instream 1,4-dioxane concentrations recorded at the stations downstream of the City of Greensboro's TZ Osborne WWTP on South Buffalo Creek (B0750000) and further downstream in Reedy Fork (B0840000) have declined significantly since the City of Greensboro entered into the 2021 Special Order by Consent (SOC) which included phased annual compliance values of 35, 31.5, and 23 µg/L in years 2021, 2022 and 2023. The mean concentration in South Buffalo Creek, downstream of the treatment plant between 2018 and 2022 was 11.8 µg/L, with maximum reading of 83 µg/L (n=52; n<1=2). The instream concentrations dropped to a mean of 3.9 µg/L, with maximum reading of 11 µg/L (n=20; n<1=1) for data collected between 2023 and 2024. Further downstream from the wastewater treatment plant in Reedy Fork, the mean concentration dropped from 7.2 µg/L, with a maximum reading of 73 µg/L (n=53; n<1=12) to a mean of 2.8 µg/L and a maximum reading of 5.4 µg/L (n=16; n<1=7) for the same time frame. See Chapter 13 (1,4-Dioxane Chapter) for more specific watershed data details with data figures and summary tables.

*Table 6-16: Reedy Fork Watershed (030300201) 2022 IR Water Quality Impairments by Stream Segment (AU#)*

<b>Stream</b>	<b>AU#</b>	<b>Classification</b>	<b>Description</b>	<b>Impairment Parameter (IR category)</b>
Reedy Fork	16-11-(1)a	WS-III; NSW	From source to UT 0.7 miles downstream of SR 2128	Benthos and fish community (5)
	16-11-(1)b	WS-III; NSW	From SR 2128 to a point 0.4 miles downstream of Moores Creek	Fish community (5)
	16-11-(9)a2	WS-V; NSW	From UT at SR 2782 to UT at SR 2778	Benthos (5)
	16-11-(9)b	WS-V; NSW	From Buffalo Creek to Haw River	Fecal coliform bacteria (4t) Aquatic passage/hydraulics (4c)
Brush Creek	16-11-4(1)a1	WS-III; NSW	From source to UT at 2085	Benthos (5)
	16-11-4(1)a3	WS-III; NSW	From UT 0.3 miles downstream of SR 3820 to a point 0.5 miles downstream of Guildford County SR 2190	Benthos and fish community (5)
Horsepen Creek	16-11-5-(0.5)a	WS-III; NSW	From source to Ballinger Road	Benthos (5)
	16-11-5-(0.5)b	WS-III; NSW	From Ballinger Road to US Hwy 220	Benthos (5)
	16-11-5-(2)	WS-III; NSW	From US Hwy 220 to Lake Brandt, Reed Fork	Benthos (5)
UT at Guilford College	16-11-5-1-(1)	WS-III; B; NSW	From source to dam at Guilford College bathing lake.	Benthos (5)
	16-11-5-1-(1)	WS-III; NSW	From dam at Guilford College bathing lake to Horsepen Creek	Benthos (5)
North Buffalo Creek	16-11-14-1a1	C, NSW	From source to Philadelphia Lake	Benthos (5); Fecal coliform bacteria (4t)
	16-11-14-1a2	C, NSW	From Philadelphia Lake to North Buffalo WWTP	Benthos and fish community (5); Fecal coliform bacteria (4t)
	16-11-14-1b	C, NSW	From North Buffalo WWTP to Buffalo Creek	Benthos and fish community, Copper, Zinc, Fecal coliform Bac (5)
South Buffalo Creek	16-11-14-2a	WS-V, NSW	From source to McConnell Rd.	Benthos and fish community (5)
	16-11-14-2b	WS-V, NSW	From McConnell Rd to US 70	Fish community (5) (Benthos)
	16-11-14-2c	WS-V, NSW	From US 70 to Buffalo Creek	Fish community, Fecal coliform bacteria (5) (Benthos)
Ryan Creek	16-11-14-2-3	WS-V; NSW	From source to South Buffalo Creek	Benthos (5)
UT to Ryan Creek	16-11-14-2-3ut5	WS-V; NSW	From source to Ryan Creek	Benthos (5)

[2022 IR link](#)

### 6.6.1.1 Reedy Fork

The headwaters of Reedy Fork start in Kernersville and flow through the towns of Oak Ridge, Summerfield, Greensboro and into the Haw River near Ossipee. Lake Brandt, Lake Higgins and Lake Townsend are drinking water supply reservoirs for the City of Greensboro and capture much of the flow from the upper portion of the Reedy Fork watershed.

The upper portion of Reedy Fork to the backwaters of Lake Brandt as well Brush Creek, Horsepen Creek and the UT to Horsepen Creek are all impaired (2020 IR) due to degraded aquatic biological community structure and instream habitat (*Table 6-16*).

The lower portion of Reedy Fork is impacted by the drainage from the highly urbanized area of Greensboro and the contributions from the wastewater discharge facilities as seen by the increase in nutrients and bacteria concentrations below the confluence with Buffalo Creek at station B0840000 (*Table 6-17*).

*Table 6-17: Reedy Fork Watershed (0303000201) Five-Year Instream Mean Concentration at Ambient Stations (2016-2020) with Seasonal/Nonseasonal Mann-Kendall Trends (Calculated at 95% Confidence).*

Watershed Information	Station	TN# (mg/L)	NOx (mg/L)	TKN (mg/L)	NH3 (mg/L)	TP (mg/L)	Fecal C. (cfu/100 mL)	Turbidity (NTU)	Conductivity (µS/cm)	Station Trend* 2000-2019 & 2010-2019 Decreasing (↓) or Increasing (↑) Seasonal (S) or Non-Seasonal (NS)	HUC 12 03030002 & Stream Class + NSW
Reedy Fork Below Lake Townsend	B0400000	0.72	0.14	0.59	0.03	0.03	280	13.2	112	TP - ↓ NS 10-19	0107 WS-V
North Buffalo Creek Urban watershed	B0480050	1.03	0.42	0.61	0.03	0.07	1186	9.4	226	NH3 - ↓ S 10-19; TP - ↓ S 00-19; TKN - ↑ NS 10-19; Fecal C - ↓ S 00-19	0105 WS-V
North Buffalo Creek Downstream of major WWTP	B0540000	3.97	3.27	0.86	0.27	0.14	633	9.4	289	NH3 - ↓ S 00-19; NOx - ↓ S 00-19 & NS 10-19; TP - ↓ NS 00-19 & S 10-19; TKN - ↓ S 00-19 & S 10-19; Conductivity - ↓ NS 00-19	0105 WS-V
North Buffalo Creek Downstream of major WWTP	B0540050	3.43	2.76	0.67	0.09	0.10	1204	10.6	249	TP - ↓ NS 00-19 & NS 10-19; NOx - ↓ NS 10-19; Fecal C - ↓ S 00-19; Conductivity - ↓ NS 00-19	0105 WS-V
South Buffalo Creek Urban watershed upstream of major WWTP	B0670000	1.00	0.31	0.69	0.03	0.07	1755	19.9	224	TKN - ↑ NS 10-19	0104 WS-V
South Buffalo Creek Downstream of major WWTP	B0750000	9.63	7.80	1.63	0.19	0.68	772	10.6	575	NOx - ↑ S 00-19 & S 10-19; TP - ↓ NS 00-19; TKN - ↑ S 00-19; Fecal C - ↓ S 00-19	0104 WS-V

Watershed Information	Station	TN# (mg/L)	NOx (mg/L)	TKN (mg/L)	NH3 (mg/L)	TP (mg/L)	Fecal C. (cfu/100 mL)	Turbidity (NTU)	Conductivity (µS/cm)	Station Trend* Information 2000-2019 & 2010-2019 Decreasing (↓) or Increasing (↑) Seasonal (S) or Non-Seasonal (NS)	HUC 12 03030002 & Stream Class + NSW
Reedy Fork Lower portion	B0840000	4.80	3.74	0.99	0.06	0.26	735	17.1	346	NH3 - ↓ S 00-19; TP - ↓ S 00-19; Fecal C - ↓ NS 00-19;	0108 WS-V

# TN is calculated as NOx + TKN. Both values were required to develop a TN value.

\* DWR conducted a seasonal or nonseasonal Mann-Kendall trend test at most AMS stations that had sufficient data available; reporting only significant increasing or decreasing trends

Reedy Fork [AU# 16-11-1(1)a, 16-11-(1)b] from the source to a point 0.4 miles downstream of Moores Creek is currently impaired (2020 IR) due to the biological community ratings at BB362 and BF54. A special benthos study was conducted in 2003, in which sample site BB386 was assessed. It is the furthest site upstream in the Reedy Fork watershed that has been sampled, but it has only been assessed once, when it received a Good-Fair bioclassification. Field staff noted that the substrate at this site was 100% sand, which likely contributed to the lower score. It is possible that the substrate was affected by residential development and agricultural land uses in the Reedy Fork headwaters.



Benthic community site BB362 is the uppermost regularly sampled Reedy Fork location and is also the most urban as outward growth of Kernersville encroaches on much of the traditionally agricultural catchment. Fish special study station BF124 is co-located with BB362. This sampling station received a Fair benthic bioclassification for the second consecutive basinwide cycle in 2018, down from Good-Fair ratings in 2003 and 2008. Though some intolerant EPT taxa were present in 2018 such as the stonefly *Pteronarcys sp.* and mayfly *Teloganopsis deficiens*, EPT richness at this location has been on the decline since rating Good in 2001. The EPTBI (5.04) was the highest recorded at this location since sampling began in 1986 suggesting a trend towards a more facultative to tolerant benthic fauna. This site likely suffers from multiple factors such as increases in impervious surfaces from the Kernersville area, some agricultural land use and limited benthic macroinvertebrate habitat. Stream bottom substrates are mostly homogenous in this stream with only woody debris available to complete the riffle kick monitoring technique. This site should be assessed again for benthos during the 2023 sampling cycle. The fish community site received a Good bioclassification when it was sampled as part of a special study in 2004. Site BF124 was not sampled in 2009 due to the lingering effects of the 2007-2008 drought in this catchment. Fish community site BF54 was sampled as part of a special study in 2009.

BB386	
Year	Bioclassification
2003	Good-Fair
BB362	
2003	Good-Fair
2008	Good-Fair
2013	Fair
2018	Fair
BF124	
2003	Fair
BF54	
2009	Fair

Reedy Fork including Lake Brandt and Lake Townsend [AU# 16-11-(3.5)a, 16-11-(3.5)b1, 16-11-(3.5)b2, 16-11-(3.5)b3] from a point 0.4 miles downstream of Moores Creek to Lake Townsend Dam (City of Greensboro water supply intake) are the two primary water supplies for the City of Greensboro and were sampled four times in 2018 (May-August).

The upper portion of Reedy Fork, located in western Guilford County, is the main feeder into Lake Brant in northern Greensboro. The landscape in this area is changing from a traditionally agricultural catchment to an urbanizing watershed. Brush Creek and Lake Higgins flow into the upper portion of Lake Brandt and capture drainage from the Piedmont Triad International Airport and a golf course community. Lake Brandt flows into Lake Townsend below Lake Brandt Road. Richland Creek/Lake Jeanette flows into the upper section of Lake Townsend and captures drainage from a densely developed portion of northern Greensboro. Lake Brandt and Lake Townsend exhibited elevated biological productivity and were determined to be eutrophic using the NC trophic status index (*Figure 6-18*). The chlorophyll *a* concentrations ranged between 11 and 30 µg/L in Lake Brandt and between 3.9 and 49 µg/L in Lake Townsend. Two of the four 2018 samples collected at the upper most station in Lake Townsend (CPFLT4) violated the state chlorophyll *a* standard of 40 µg/L (June and July 2018). The chlorophyll *a* concentrations declined moving downstream and were the lowest near the dam and the drinking water intake (station CPFLT8). The chlorophyll *a* concentrations were fairly consistent throughout Lake Brandt in 2018. For additional information on these lakes, see the 2018 [ESS Lakes Report](#) and [map](#) of the lake stations.

Brush Creek [AU# 16-11-4-(1)a2, 16-11-4-(1)a3] originates under the Piedmont Triad International Airport in Greensboro. It is then impounded at Marriot Drive by a hotel to create a retention pond. The stream then flows beside NC68 for about one mile before entering a residential area and golf course. Brush Creek runs through two golf courses, then is dammed to form Lake Higgins. The stream’s riparian zone has been removed through both golf courses. The only tributary is impounded to form Cardinal Lake, located in Cardinal Country Club.

The upstream-most site on Brush Creek, benthic community site BB093, was sampled as a special study in 2003. Field staff observed that the instream habitat was composed of 100% sand. The stream was shallow and filled with sediment and instream habitat was severely limited without riffles and with very few snags and leaf packs. Pools were absent, but erosion did not appear to be an issue. The riparian area was extensive and wooded, with plenty of understory shrubs. The benthic community was dominated by high pollution-tolerant taxa. Moving downstream, Brush Creek has a fish community station (BF69) located upstream of the Cardinal Country Club which maintained a Good-Fair bioclassification rating through two sampling events, in 2004 and 2009. Downstream of Cardinal Country Club are co-located benthic macroinvertebrate community (BB364) and fish community (BF78) monitoring stations. These two biological monitoring stations were sampled on separate events. The fish community was sampled in 2004 and reported a Fair bioclassification rating. Station BB364 has been sampled four times since 1998, the most recent of which was in 2013. All but one of those sampling events have resulted in a bioclassification of Fair (the site rated Poor in 1999). Field staff noted that the benthic community at this site is dominated by pollution-tolerant species, which is an indicator that the system is stressed. Instream habitat at this site was noted as 95% sand in 2013.

<b>BB093</b>	
<b>Year</b>	<b>Bioclassification</b>
2003	Not Rated
<b>BF69</b>	
2004	Good-Fair
2009	Good-Fair
<b>BF78</b>	
2004	Fair
<b>BB364</b>	
2013	Fair

Two segments of Brush Creek from its source to Lake Higgins are impaired for benthos [AU#16-11-4-(1)a1] or benthos and fish [AU#16-11-4-(1)a3]. The most likely causes of stress to the macroinvertebrate and fish communities are nonpoint sources of runoff, sedimentation and lack of instream habitat for colonization. The most likely sources of these stressors are the change in hydrology (flashiness) in the catchment due to the high level of impervious surface associated with the airport and lack of adequate riparian buffer throughout the golf courses, which limits the ability of the riparian zone to filter and reduce impacts from runoff.

Horsepen Creek [16-11-5-(0.5)a ,16-11-5-(0.5)b, and 16-11-5-(2)] is a drinking water supply stream for Lake Brandt, and an extensively urban stream. Draining the northeastern portion of Greensboro (including PTI Airport), this stream has very little catchment area that is not developed. Recent development pressures have been very heavy due to growth and have essentially eliminated instream habitat for macroinvertebrates. Much of the poor habitat of Horsepen Creek may be attributed to natural sandy substrates; however, high urban development and high percentages of impervious surfaces have contributed to high water velocities after rain events which, in turn, lead to severely eroded banks and stream incision, which then loads the water with large amounts of silt thereby affecting the habitat and benthic fauna with an abundance of sediment. Additional evidence that the water quality of Horsepen Creek is directly impacted by increasing urbanization is the elevated specific conductance at all of the monitoring sites. Based on these observations, this stream may be a good candidate for a stream bank stabilization project.

Horsepen Creek spans three assessment units before flowing into Lake Brandt. The furthest upstream benthic macroinvertebrate community station (BB369) was sampled in 2011 and received a Fair bioclassification. Downstream from station BB369 are co-located benthic macroinvertebrate (BB427) and fish community (BF71) monitoring stations. The most recent sampling events at these stations reported a Good-Fair bioclassification rating for the fish community in 2009 and a Fair bioclassification rating for the benthic macroinvertebrate community in 2013. The entire stream reach of Horsepen Creek is impaired for benthos.

<b>BB369*</b>	
<b>Year</b>	<b>Bioclassification</b>
2011	Fair
<b>BF71</b>	
2004	Fair
2009	Good-Fair
<b>BB427</b>	
2003	Poor
2008	Fair
2013	Fair
*Special Study	

UT to Horsepen Creek [16-11-15-1-(1)] shares similar land use characteristics with the mainstem of Horsepen Creek. The entire catchment is highly developed, and the tributary is impounded twice: once in its headwaters on the campus of Guilford College to create a recreational lake and again downstream on the campus of the former American Hebrew Academy, also as a recreational lake. While buffers appear to be mostly intact along the course of the stream, heavy development in the catchment, coupled with the impoundments that hinder recolonization after drought or storm events are likely impacting water and habitat quality. Low flow conditions during summer months may also be impacting the aquatic community in this slate belt stream. Two sites were sampled on this tributary in 2013 as part of a special study. Site BB525 at Robinridge Park rated Fair and site BB524, just upstream of the American Hebrew School impoundment, rated Poor. As a result, UT to Horsepen Creek is impaired for its entire length for benthos.

<b>BB525*</b>	
<b>Year</b>	<b>Bioclassification</b>
2013	Fair
<b>BB524*</b>	
2013	Poor
*Special Study	

Reedy Fork ([AU# 16-11-(9)a1, 16-11-(9)a2, 16-11-(9)a3, 16-11-(9)b]) from Lake Townsend Dam to the Haw River is a much more rural section of the watershed, flowing mainly through agricultural and forested lands. The land use changes in this watershed have likely contributed to the declining water quality assessed in this section of Reedy Fork since the 2005 basin plan. The land use change at ambient monitoring station B0400000 (above the confluence with Buffalo Creek) shows a 7% increase in development between 2001 and 2019 and a 4% increase at station B0840000 lower in Reedy Fork below the confluence with Buffalo Creek. There is an estimated 15.6% impervious cover at station B0840000 (See the Chapter 2 Appendix – *Land Use Land Cover for AMS and Coalition Station Watersheds*).

As of 2013, the benthic macroinvertebrate assessment found that the community structure was becoming more dominated by pollutant-tolerant species, resulting in a Fair rating at station BB404 (SR 2728). This stretch of Reedy Fork is in a more rural area of the county and benthic community station BB404 has much better habitat qualities than other benthos sites on Reedy Fork, with the absence of wide riparian buffers being the most glaring deficiency. Instream habitats are typical of Carolina Slate Belt-type streams; there was heavy diatom, *Fissidens* and *Podostemum* growths (periphytic growth) in the riffles, which were present at the bridge and at the end of the reach. Otherwise, the stream is one long shallow run/pool at low flow with shallow side snags and undercuts and an open canopy at the bridge. The bioclassification of this segment has historically been Good-Fair with the exception of a Fair rating in 2003 when the stream was sampled during high flow. Sampling in 2008 resulted in Reedy Fork once again rating Good-Fair. Following 2008, this sampling station received a Fair benthic bioclassification. The low EPT richness (13) was on the cusp of receiving a Good-Fair bioclassification; however, the elevated EPTBI (6.15) suggested a continued trend towards a more tolerant benthic fauna. Land use data suggested less agricultural land use in the catchment in 2011 compared to in 2006, 2001 and 1992, and impervious surfaces and developed land continued to increase throughout those years. Increased rainfall in 2018 coupled with increased impervious surfaces and developed land could have exacerbated increased nonpoint source pollution and declines in benthic metrics. This stream reach is on the impaired waters list (2022 IR) for benthos.



BB404	
Year	Bioclassification
2008	Good-Fair
2013	Fair
2018	Fair
BF65	
2013	Good
BB32	
2008	Good-Fair
2018	Good-Fair

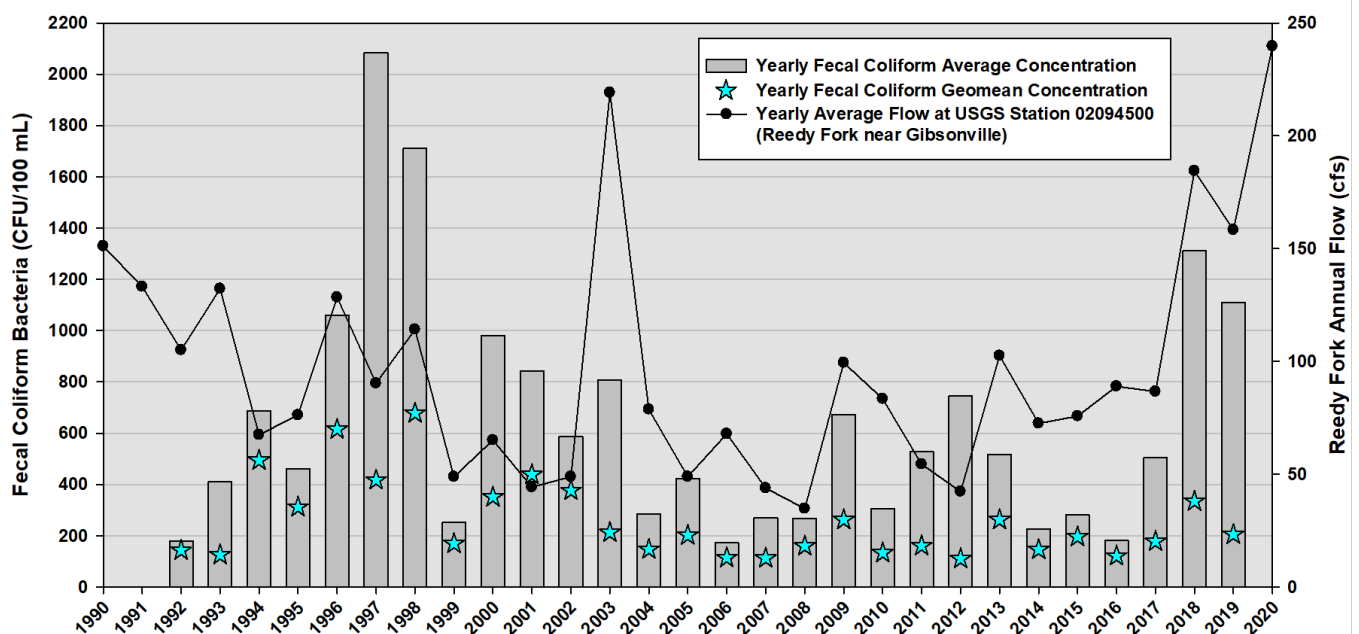
Fish community site BF65 showed a slight decline in NCIBI score in 2013 due to loss of one species of sunfish and piscivores. Additionally, the total species diversity and diversity of suckers were lower than expected compared with those at reference sites. The fish community shows a low diversity for a stream of this size which is most likely related to upstream impoundments and lower water quality downstream below the fork's confluence with Buffalo Creek. Only 24 fish species are known from the site, including three species of darters, one intolerant species and three nonindigenous species, and the number of species has declined by 41% since 1998. Dominant species observed at the site were sandbar shiner and bluehead chub (18% each). Suckers have been absent since 1998. Trophic metrics have been relatively stable since 1998 and the site has consistently been rated Good since 1993. Both BB404 and BF65 should be monitored during the 2023 sampling season.

This segment of Reedy Fork ([AU# 16-11-(9)a2] 2.2 miles from the UT at SR 2728 to UT at SR 2778) remains listed as impaired for aquatic life on the 2022 IR list.

Reedy Fork [AU# 16-11-(9)b; 8.6 miles] from Buffalo Creek to Haw River is impaired for fecal coliform bacteria (2022 IR, category 4t; [Table 6-16](#)). Reedy Fork station B0840000 was sampled as part of a large monitoring study from May to July 2002. The results showed a rolling geometric mean of at least five samples in 30 days ranging from 462 to 811 cfu/100 mL. This study resulted in this segment of Reedy Fork being included on the 2006 303(d) impaired waters list. A second sampling study in July and August 2017 was done to confirm the bacteria impairment and verified the need for a TMDL. The geometric mean was 226 cfu/100 mL, exceeding the geometric mean standard of 200 cfu/100 mL. An addendum to the 2005 Haw River Fecal Coliform TMDL was approved by USEPA on July 9, 2018 ([2018 Reedy Fork/Haw River TMDL Addendum](#); additional details are included in the watershed TMDL discussion above).

Monthly surface water monitoring at station B0840000 continues to show elevated fecal coliform bacteria concentrations ([Figure 6-26](#)). As described in the TMDL (above), there are wet and dry weather sources of bacteria. The instream concentrations are not directly related to flows, however the higher precipitation and stream flows in 2018 and 2019 resulted in a substantial increase in the annual mean (1,311 and 1,110 cfu/100 mL) and geomean (335 and 205 cfu/100 mL, respectively) concentrations ([Figure 6-26](#)). Bacteria source detection and reduction measures are still needed throughout the Reedy Fork watershed, especially in the highly urban watersheds of North and South Buffalo creeks. Contributions from North and South Buffalo creeks are driving the higher concentrations detected in the lower portion of Reedy Fork (at station B0840000), as seen in [Table 6-17](#).

*Figure 6-26: Reedy Fork Station B0840000 Fecal Coliform Bacteria Yearly Average and Geomean Concentration with Flow (USGS Station 02094500 near Gibsonville).*

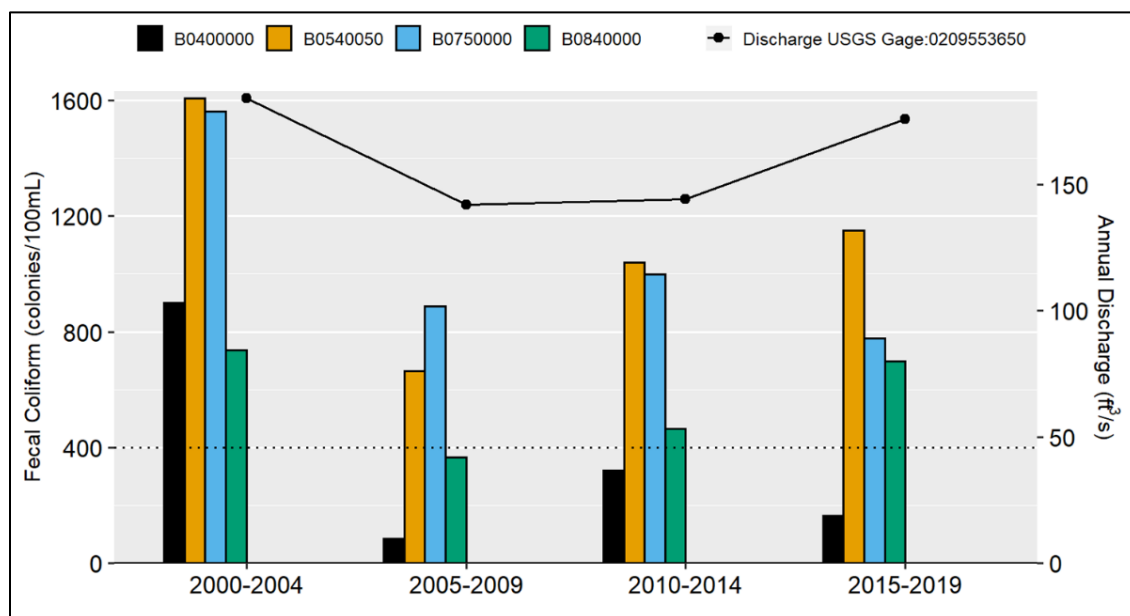


Benthic community site BB032, Reedy Fork at NC 87, drains portions of western Alamance County and large areas of Guilford County originating near Kernersville, NC. This sampling station is co-located with AMS Station B0840000 and is the downstream-most biological monitoring station on Reedy Fork. It is approximately 0.25 miles downstream from a low-head dam and one mile upstream from its confluence with the Haw River. Reedy Fork Mobile Home Park WWTP is approximately a half mile upstream from the road crossing at NC 87.

BB032	
Year	Bioclassification
2008	Good-Fair
2018	Good-Fair

This site received a Good-Fair benthic bioclassification in 2018 for the second consecutive basinwide sampling event. Both the NCBI (5.83) and EPTBI (4.80) were the lowest recorded at this station since benthic sampling began here in 1983. These metrics and the second consecutive Good-Fair benthic bioclassification suggested slight water quality improvements compared to the many Fair ratings received in previous years (1998 and 1983-1989), however the specific conductance remained elevated, and the benthic fauna were mostly facultative to tolerant taxa. It is important to note that this site has historically fluctuated between these two bioclassifications. This site was not sampled in 2003 due to continuous high flows.

Figure 6-27: Reedy Fork Watershed Five Year Average Fecal Coliform Concentrations with Corresponding Buffalo Creek Flow.



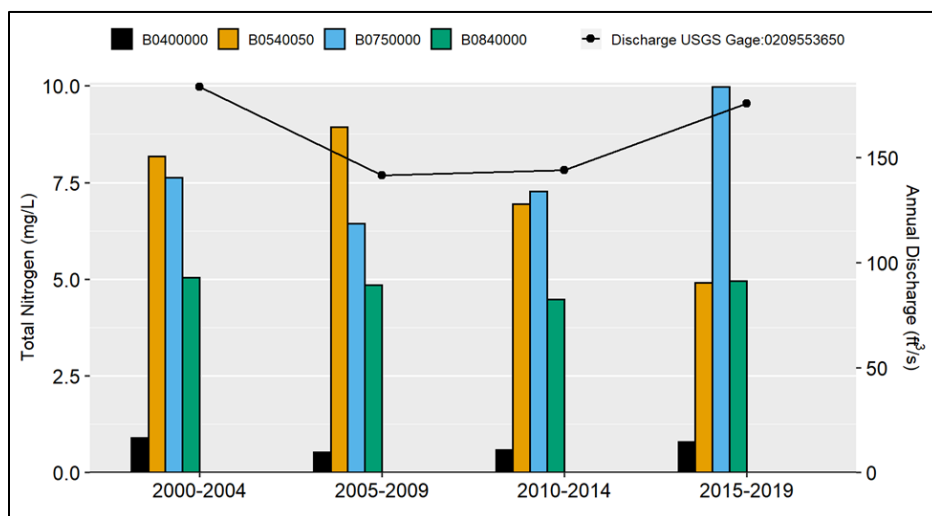
The stations include the upstream Reedy Fork Station B0400000 (black bar), North Buffalo Creek Station B0540050 (orange bar), South Buffalo Creek Station B0750000 (blue bar), lower Reedy Fork Station B0840000 (Green Bar) and Buffalo Creek flow at USGS Gage Station 02095536500 (black line with dot).

The Reedy Fork watershed (0303000201) had the highest average instream nutrient concentrations (2015-2019) compared to the other watersheds in the Haw River subbasin (Table 6-10). In the mainstem Reedy Fork, the total nitrogen and total phosphorus concentrations were much higher at the downstream Reedy Fork station (B0840000) (Figure 6-30 and Figure 6-31). Station B0840000 is approximately 8 miles downstream of the confluence with Buffalo Creek and 9.3 miles downstream from station B0400000 (Figure 6-16). Total nitrogen is made up of nitrate-nitrite plus TKN (Total Kjeldahl Nitrogen, which is the organic nitrogen + ammonia concentration). The proportions of these different components of nitrogen

in surface waters can often help explain what the potential sources of nitrogen are (see Chapter 2, section 2.5.7 for more information).

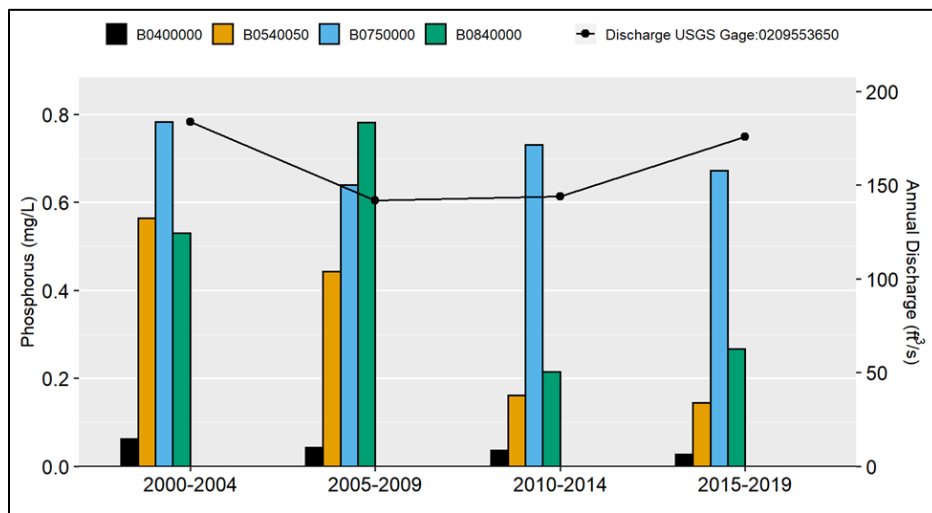
Between 2015 and 2019, approximately 70 to 80% of the nitrogen at the upstream Reedy Fork station B0400000 was organic nitrogen (TKN-NH3) and the concentration was about 2.5 to 5.8 times higher than the NOx concentration (*Figure 6-32*). There are zero major and two minor wastewater dischargers to this section of Reedy Fork.

*Figure 6-28: Reedy Fork Watershed Five Year Average Total Nitrogen and Total Concentrations with Corresponding Buffalo Creek Flow at Stations B0400000, B0540050, B0750000, B0840000.*



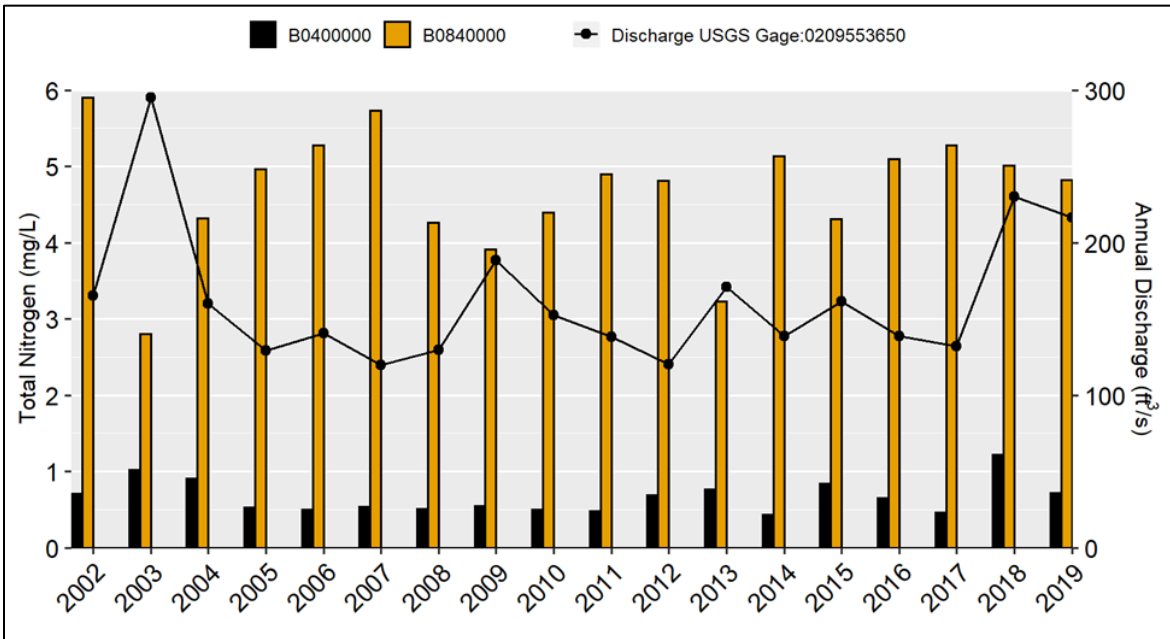
The stations include the upstream Reedy Fork Station B0400000 (black bar), North Buffalo Creek Station B0540050 (orange bar), South Buffalo Creek Station B0750000 (blue bar), Lower Reedy Fork Station B0840000 (green bar) and Buffalo Creek flow at USGS Gage Station 02095536500 (black line with dot).

*Figure 6-29: Reedy Fork Watershed Five Year Average Total Phosphorus and Total Concentrations with Corresponding Buffalo Creek Flow at Stations B0400000, B0540050, B0750000, B0840000*



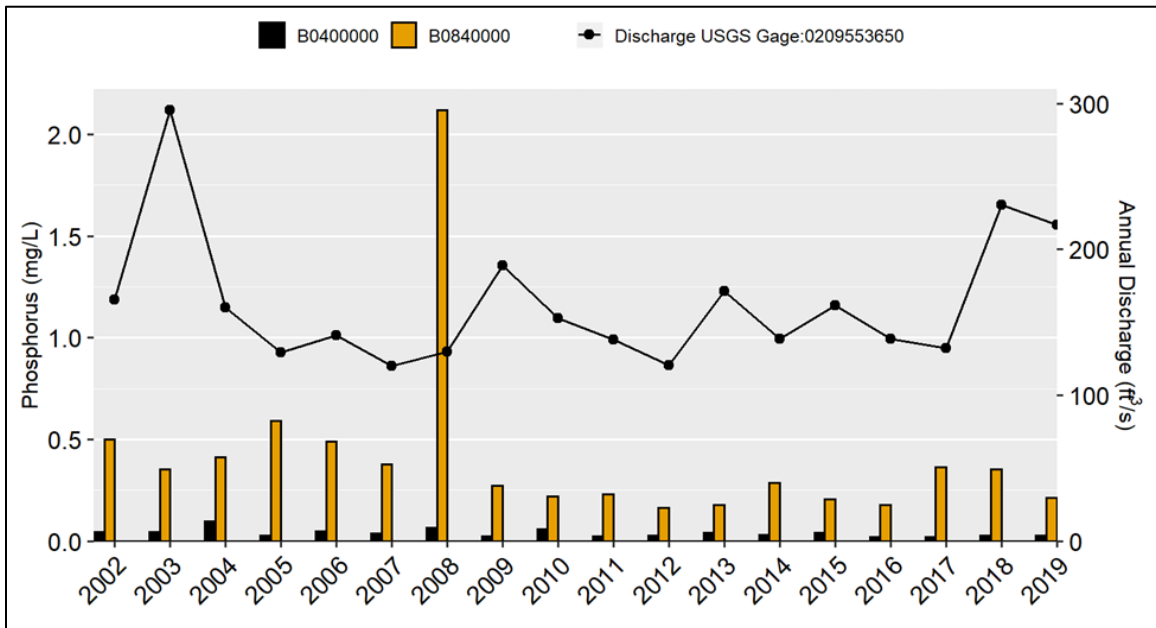
The stations include the upstream Reedy Fork Station B0400000 (black bar), North Buffalo Creek Station B0540050 (orange bar), South Buffalo Creek Station B0750000 (blue bar), Lower Reedy Fork Station B0840000 (green bar) and Buffalo Creek flow at USGS Gage Station 02095536500 (black line with dot).

Figure 6-30: Reedy Fork Annual Average Total Nitrogen at Stations B0400000 and B0840000



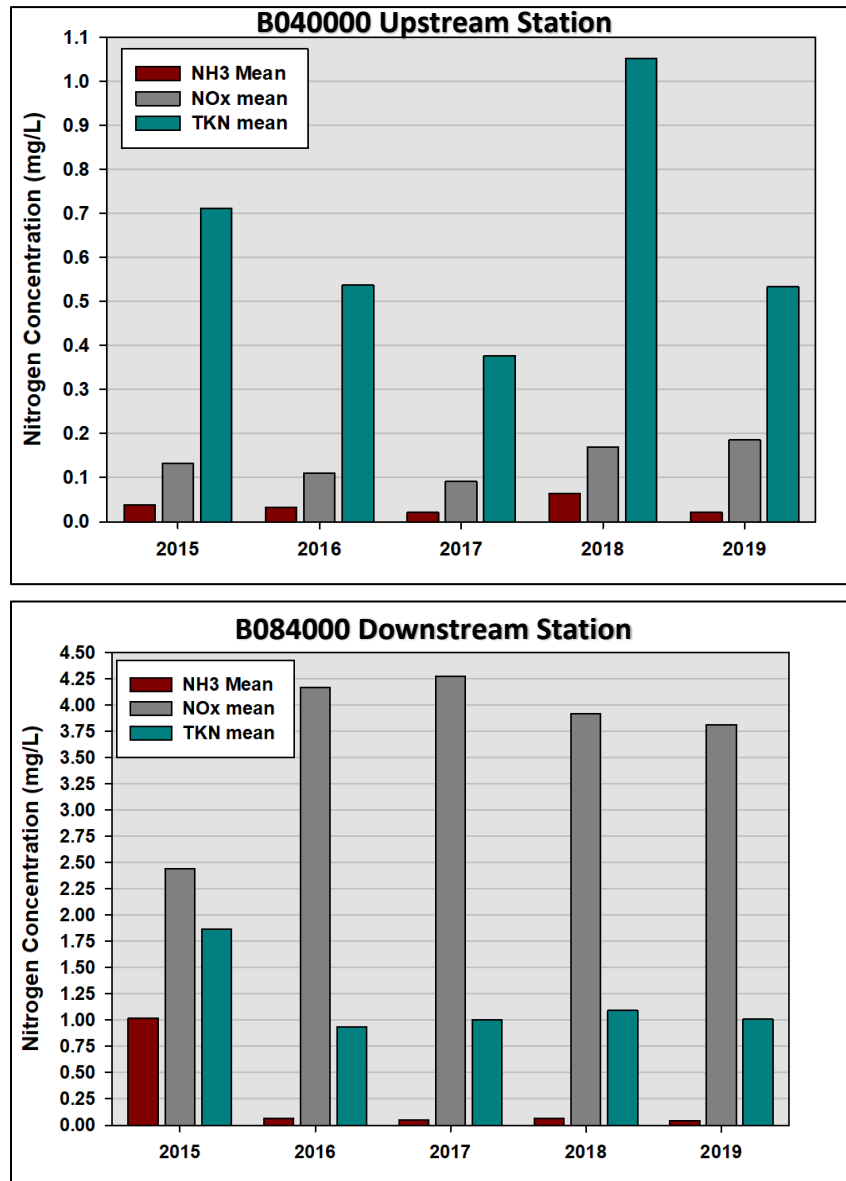
Concentrations at the upper station B0400000 (black bar) and the lower station B0840000 (orange bar) and the corresponding Buffalo Creek stream flow (USGS Gage Station 0209553650).

Figure 6-31: Reedy Fork Annual Average Total Phosphorous at Stations B0400000 and B0840000



Concentrations at the upper station B0400000 (black bar) and the lower station B0840000 (orange bar) and the corresponding Buffalo Creek stream flow (USGS Gage Station 0209553650).

Figure 6-32: Reedy Fork Nitrogen Constituent Concentrations at B0400000 (Upstream Station) and B0840000 (Downstream Station)

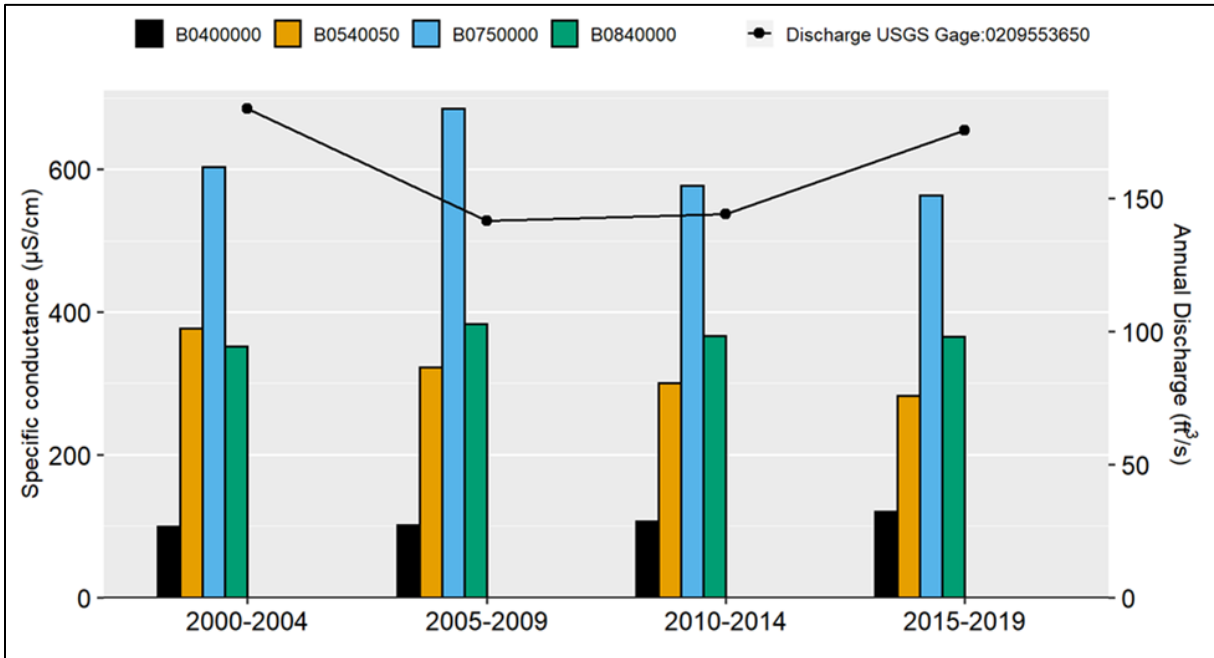


The B0400000 upstream station is dominated by TKN/organic nitrogen. The B0840000 downstream station is dominated by NOx/inorganic nitrogen. Note: The nitrogen concentration axis is different for each graph.

During this same time period (2015-2019), approximately 55 to 82% of the nitrogen at the downstream station B0840000 was inorganic NOx nitrogen and the concentration was about 2.9 to 4.8 times higher than the organic nitrogen fraction, indicative of a point source contribution. Greensboro’s major wastewater treatment plants discharge into the receiving streams that drain to the downstream Reedy Fork station. This could also be seen in the elevated conductivity levels at the downstream station B0840000, indicating a large source of pollution to the watershed (Figure 6-33 and Table 6-17). North and

South Buffalo creeks contributed high concentrations of nitrogen, phosphorous and other wastewater constituents that resulted in high conductivity levels downstream of their discharge point (*Figure 6-28, Figure 6-29 and Figure 6-33*).

*Figure 6-33: Reedy Fork Watershed Five Year Average Specific Conductance Level with Corresponding Buffalo Creek Flow.*



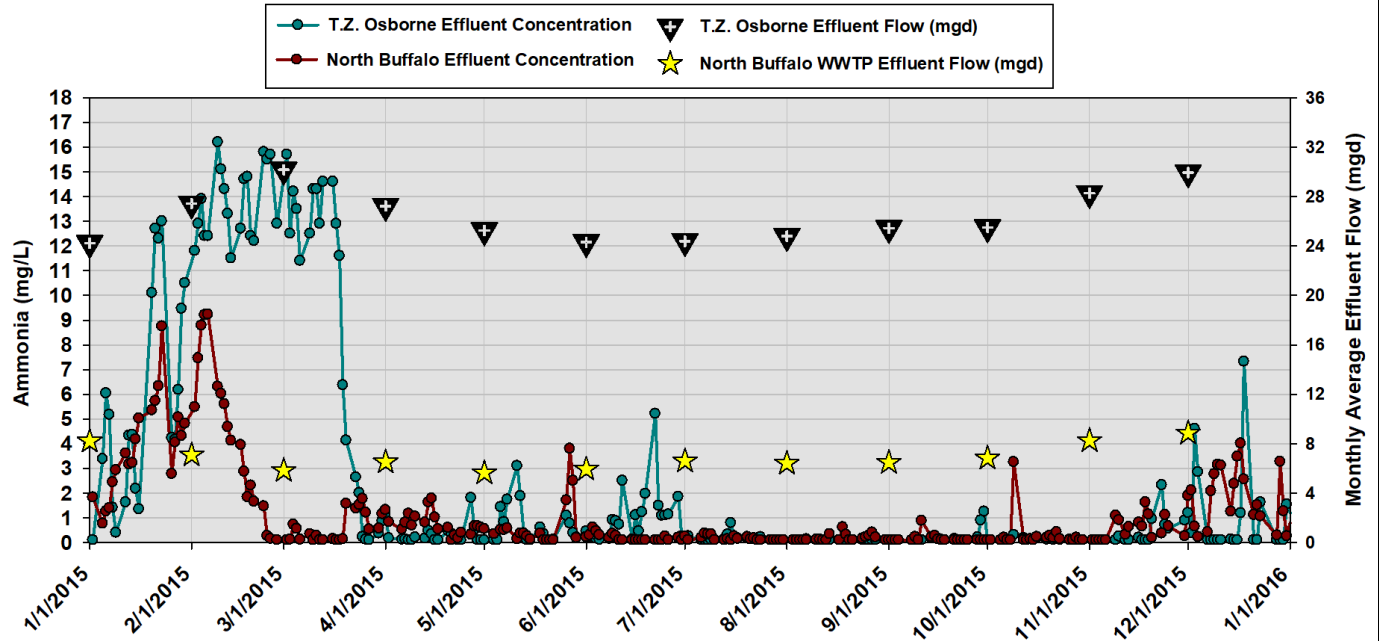
The stations include the upstream Reedy Fork Station B0400000 (black bar), North Buffalo Creek Station B0540050 (orange bar), South Buffalo Creek Station B0750000 (blue bar), lower Reedy Fork Station B0840000 (green bar) and Buffalo Creek flow at USGS Gage Station 02095536500 (black line with dot).

The 2015 elevated yearly average instream ammonia concentration of 1.02 mg/L at station B0840000, as seen in *Figure 6-32*, was likely the result of elevated effluent ammonia concentrations discharged from the two City of Greensboro’s wastewater treatment plants (*Figure 6-34*). The instream monthly ammonia concentrations at B0840000 were generally much higher in 2015 than those recorded in 2016, with a high reading of 5.2 mg/L on February 10, 2015 (*Table 6-18*). The T.Z. Osborne WWTP effluent concentration ranged between 11.4 and 16.2 mg/L with an average of 13.67 mg/L from February to mid-March 2015, well above their monthly average winter permit limit of 4.0 mg/L. They exceeded their monthly ammonia limit in January, February and March 2015. There were several issues that occurred at the treatment plants that resulted in the inability to meet their limits. The city corrected the issues, and the plant went back into compliance in April 2015.

An overall five-year (2016-2020) turbidity average of 12.9 NTU for all stations in the Reedy Fork watershed was the lowest HUC 10 average turbidity concentration in the Haw River Watershed (*Table 6-10*). The most downstream station (B0840000) generally had the highest concentration of all the stations within the Reedy Fork watershed and there appears to be a source contributing to the higher turbidity levels between the upper Reedy Fork station (B040000) and the most downstream stations on North and South

Buffalo creeks (*Figure 6-35*). Buffalo Creek and the lower portion of Reedy Fork are much more rural in nature. It is critical to protect the existing riparian buffers and add BMPs to the landscape to limit sediment as well as nutrients and fecal coliform bacteria from running off to the streams.

*Figure 6-34: City of Greensboro’s Wastewater Treatment Plants 2015 Effluent Daily Ammonia Concentrations (mg/L) and Monthly Average Flow (MGD)*

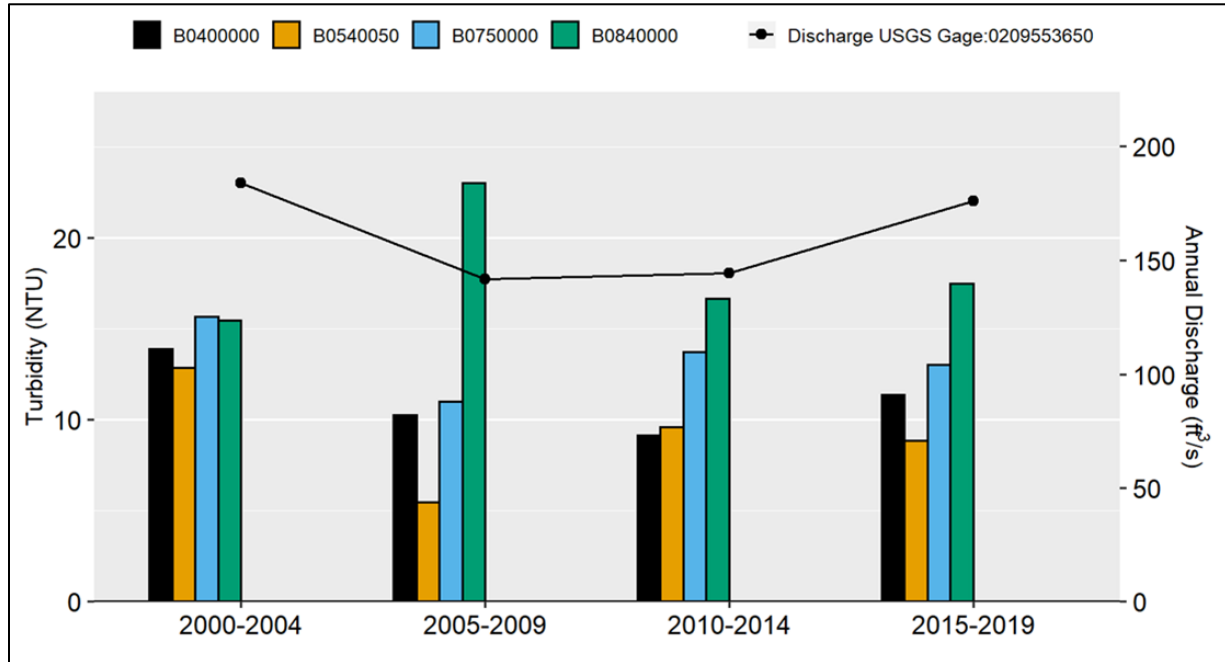


*Table 6-18: Reedy Fork Instream Monitoring Station B0840000 Monthly Ammonia Concentration for 2015 and 2016 for Comparison*

Month Sampled	2015		2016	
	Sample Date	NH <sub>3</sub> (mg/L)	Sample Date	NH <sub>3</sub> (mg/L)
January	1/13/2015	0.31	1/20/2016	0.1
February	<b>2/10/2015</b>	<b>5.2</b>	2/17/2016	0.05
March	3/11/2015	1.7	3/30/2016	0.02*
April		ND	4/18/2016	0.09
May	5/12/2015	0.41	5/25/2016	0.02
June		ND	6/28/2016	0.09
July	7/6/2015	0.1	7/21/2016	0.07
August	8/11/2015	0.02*	8/30/2016	0.1
September		ND	9/21/2016	0.07
October	10/13/2015	0.06	10/26/2016	0.03
November	11/23/2015	0.32	11/21/2016	0.02
December		ND	12/19/2016	0.09
<b>Yearly Average</b>		<b>1.02</b>		<b>0.06</b>

\*Value recorded at the PQL of 0.02 mg/L; ND = No Data

Figure 6-35: Reedy Fork Watershed Five Year Average Turbidity Levels with Corresponding Buffalo Creek Flow



The stations include the upstream Reedy Fork Station B0400000 (black bar), North Buffalo Creek Station B0540050 (orange bar), South Buffalo Creek Station B0750000 (blue bar), lower Reedy Fork Station B0840000 (green bar) and Buffalo Creek flow at USGS Gage Station 0209553650 (black line with dot).

### 6.6.1.2 North Buffalo Creek

North Buffalo Creek has a drainage area of approximately 44 square miles and drains a large portion of downtown Greensboro. The watershed at ambient monitoring station B0540050 (lowest in the watershed) is about 75% developed with an average impervious coverage across the watershed of approximately 27%, which is a level high enough to result in significant measurable impacts to water quality (Schueler, 1994). North Buffalo Creek has been listed as impaired for aquatic life due to conditions that impact the benthic macroinvertebrate (aquatic bugs) and fish communities ([Table 6-16](#), also see the Chapter 2 Appendix – *Land Use Land Cover for AMS and Coalition Station Watersheds*). The stream is also impaired (2022 IR) due to elevated fecal coliform bacteria concentrations and has an approved TMDL since 2004 ([Table 6-12](#) and [Table 6-16](#)). The benthic and fish data continue to indicate that the aquatic life throughout this watershed is impacted by the degraded water quality. The North Buffalo Creek WWTP (NC0024325; 16 MGD) closed in October 2017 which has resulted in a reduction in the instream nitrogen and phosphorus concentrations.

The North Buffalo Creek fecal coliform bacteria TMDL was described in detail above (in section 6.6.1 general information on Reedy Fork watershed TMDLs). The primary sources were identified as domestic pets during wet conditions and exfiltrating sanitary sewer collection systems during dry conditions. The percent load reduction necessary to meet TMDL requirements associated with the all weather conditions water quality target is 96% from MS4 sources and 93% from nonpoint sources ([2004 North Buffalo Creek TMDL](#)). The North Buffalo Creek at Summit Avenue was designated as the TMDL compliance point [the

closest ambient monitoring station is about 1.3 miles downstream (UCFRBA station # B0480050)]. The TMDL reductions are based on achieving the fecal coliform bacteria water quality standard (5-in-30 geomean concentration < 200 cfu/100mL) under the most critical weather and stream flow conditions identified within the simulation period (August 1998-August 2001). Data used for the TMDL was collected by Greensboro’s Stormwater Management Division, Piedmont Triad Council of Government and Cone Mill WWTP. The data presented here to show how water quality varies over time in this watershed are monthly ambient monitoring data only, collected by the Upper Cape Fear River Basin Association Coalition or DWR (Figure 6-36 and Figure 6-37). Station B0480050 is the station closest to the TMDL compliance point and shows how variable the yearly mean and geomean can be and are not directly correlated with the annual flow as the TMDL indicated (Figure 6-36). The five-year means show that the fecal coliform bacteria has been fairly consistent in this watershed over the last 10 years, even given the higher flows in the last several years (Figure 6-37). The five-year means are well over 400 cfu/100mL. The City of Greensboro needs to continue to implement efforts to identify and reduce sources of bacteria to North Buffalo Creek.

The impacts from nonpoint sources in North Buffalo Creek at station B0540000 are also discernible from the flow separated graphics as average fecal coliform bacteria levels are 2,064 cfu/100 mL during high flows ( $\geq 43.4$  cfs) while average values are 285 cfu/100 mL during lower flow periods ( $\leq 19$  cfs), 86% lower (Figure 6-38).

Figure 6-36: Annual Mean and Geomean Fecal Coliform Bacteria Concentrations and North Buffalo Creek Flow (USGS Gage 02095500) at Ambient Monitoring Station B0480050

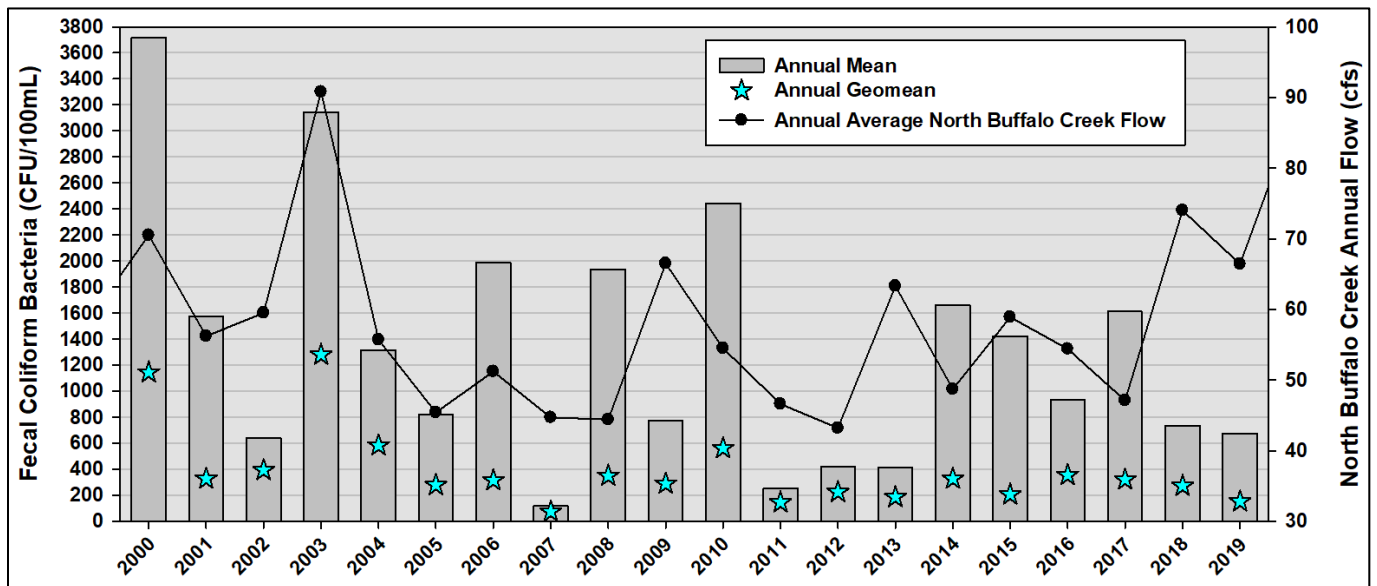
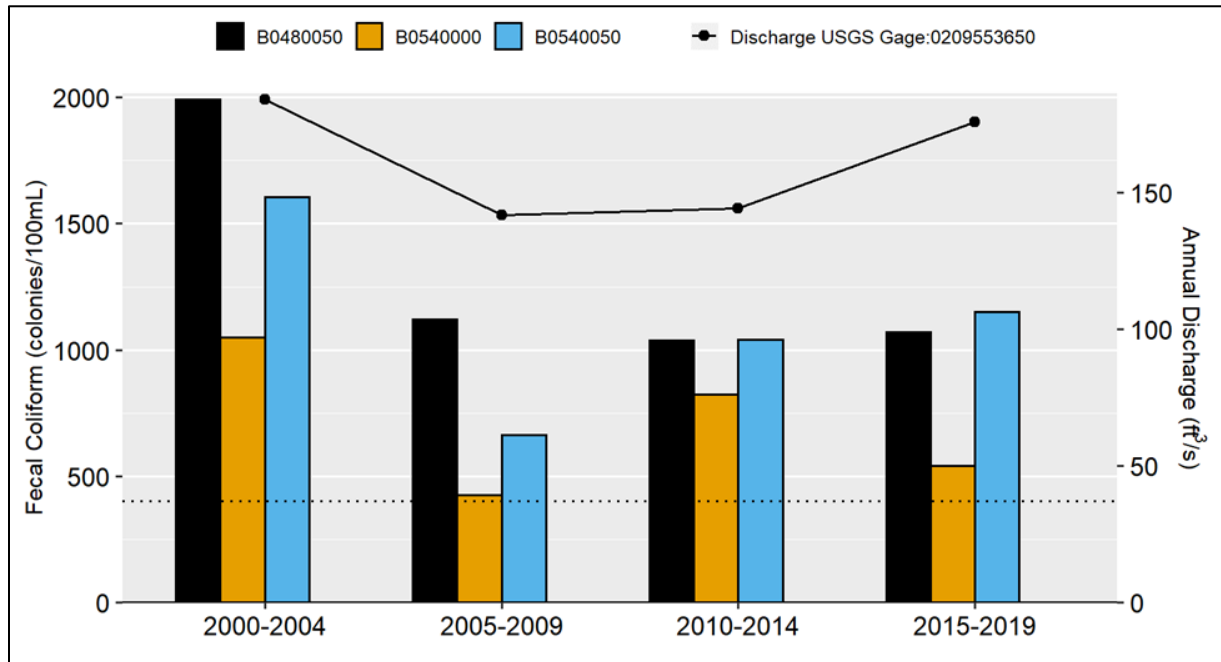


Figure 6-37: Five Year Mean Fecal Coliform Bacteria Concentration for the Three Stations on North Buffalo Creek Between 2000 and 2019 with Corresponding Buffalo Creek Flow



The Stations Include the Upstream North Buffalo Creek Station B0480050 (Black Bar), North Buffalo Creek Station B0540000 Downstream of former WWTP (Orange Bar), North Buffalo Creek Station B0540050 near confluence with Buffalo Creek (Blue Bar), and Buffalo Creek Flow at USGS Gage Station 02095536500 (Black Line with Dot).

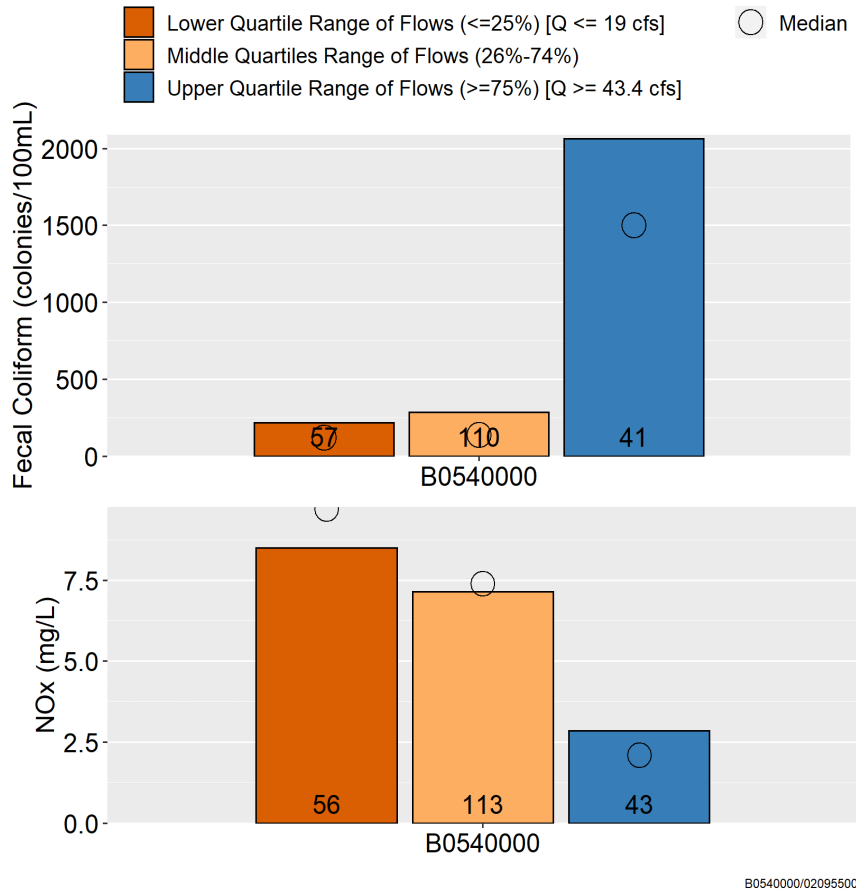
The Reedy Fork HUC 10 subwatershed (0303000201) has the highest instream nutrient concentrations out of the seven subwatersheds in the Haw River subbasin (Table 6-10). This is mainly driven by the concentrations in North and South Buffalo creeks as a result of urban runoff and a large municipal wastewater discharge into relatively small streams (Summer 7Q10: North Buffalo Creek = 0.9 cfs and South Buffalo Creek = 2.1 cfs).

The instream nitrogen and phosphorus concentrations in North Buffalo Creek are significantly higher at the two downstream stations through 2017 (Figure 6-39) at which point the North Buffalo Creek WWTP ceased discharging to the creek (October 6, 2017). The concentration of nitrogen and phosphorus starting in 2018 are similar at all the stations in the North Buffalo Creek (Figure 6-39). The average total nitrogen concentration at B0540000 (approximately 3.4 miles downstream of the WWTP) between 2010 and 2016 was about 8.0 mg/L and dropped to about 1 mg/L in 2018 and 2019. The constituents of total nitrogen shifted once the treatment plant closed. The NOx (nitrate+ nitrite) dropped from between 5.5 and 7.5 mg/L to about 0.5 mg/L and the TKN (organic nitrogen + ammonia) dropped from about 1 mg/L to about 0.6 mg/L in 2018 and 2019 (Figure 6-40). Ammonia and total phosphorus concentrations also dropped once the treatment plant closed (Figure 6-41 and Figure 6-42).

The impacts from the North Buffalo WWTP point sources is easily discernible from the flow separated analysis of the instream NOx concentrations. NOx is the primary nitrogen constituent discharged from

most wastewater treatment facilities. The average NOx concentration in North Buffalo Creek during low flow conditions ( $\leq 19$  cfs) was 8.50 mg/L, during normal or medium flow was 7.13 mg/L and during high flows ( $\geq 43.34$  cfs) was 2.90 mg/L, almost 66% lower (*Figure 6-38*). Future flow separated analysis will need to compare pre- and post-WWTP closure (October 2017).

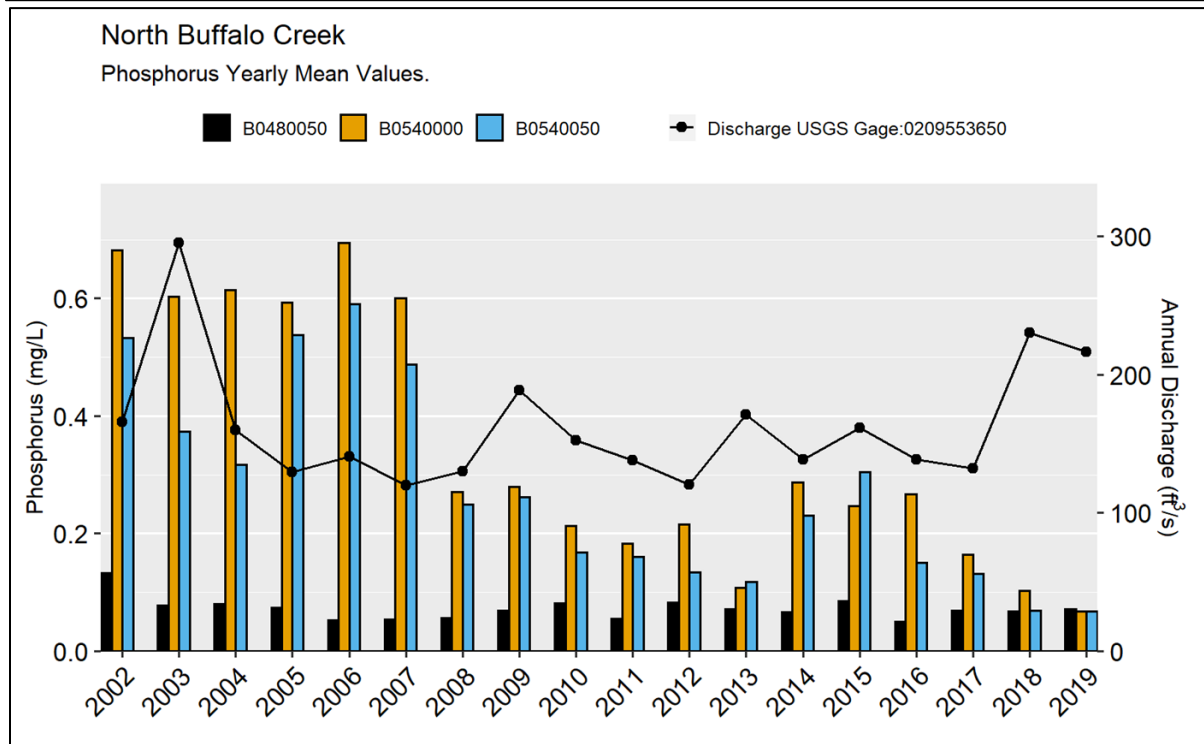
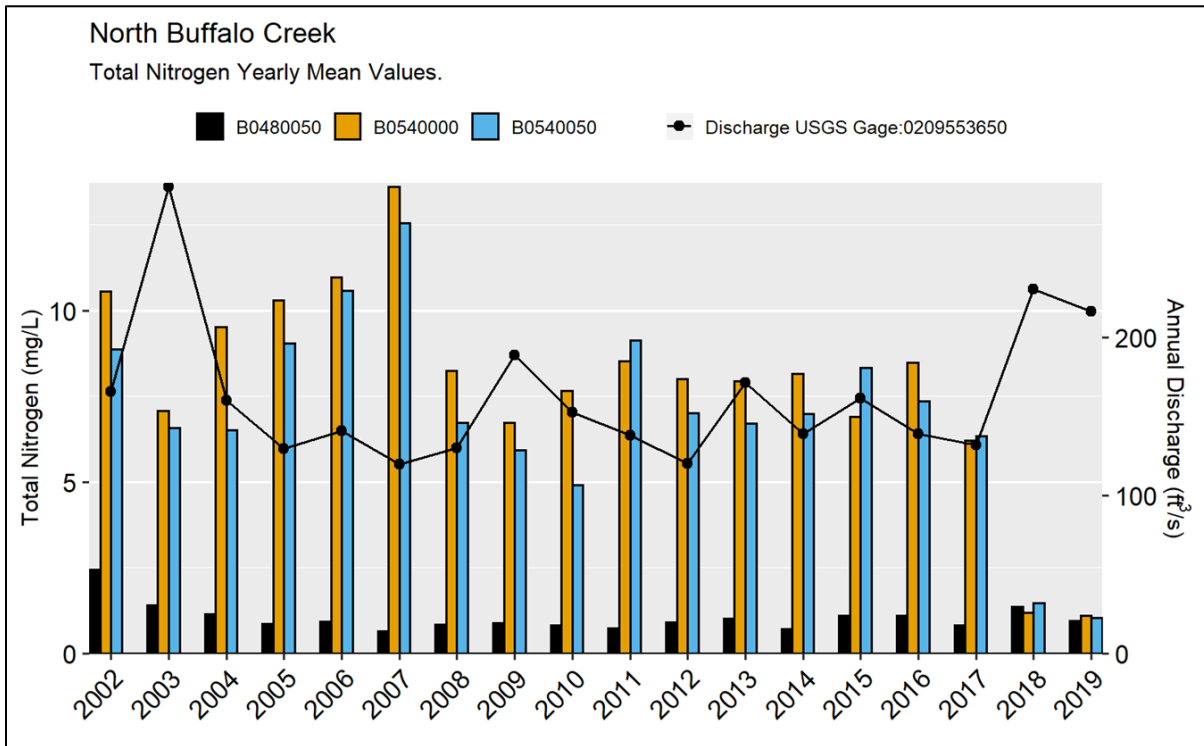
*Figure 6-38: North Buffalo Creek Flow Separated Mean and Median Concentrations for Fecal Coliform Bacteria and NOx at Station B0540000 (2002-2020) and Co-located USGS Gage Station 02095500 (1998-2020)*



Numbers on bar graph are the number of water quality samples that fall into that specific flow bin from the 2002-2020 dataset.

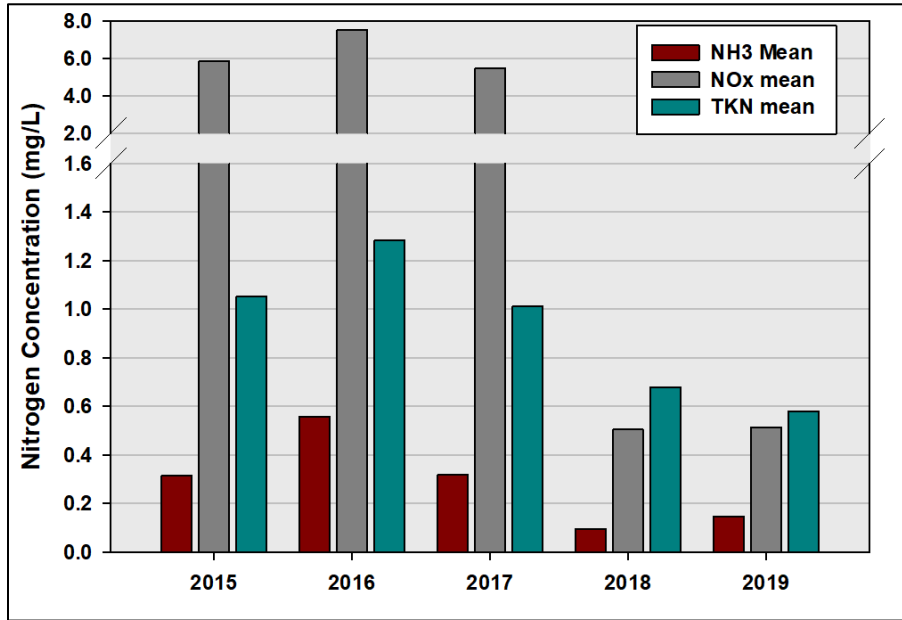
DWR conducted a screening level Mann-Kendall trend test and found a seasonal decreasing trend in nitrate/nitrite (NOx), ammonia and TKN and a nonseasonal decreasing trend in TP at the downstream station (B0540000) on North Buffalo Creek calculated at 95% confidence for data collected from 2000-2019 (*Table 6-17*).

Figure 6-39: North Buffalo Creek Instream Total Nitrogen and Total Phosphorus Concentrations (mg/L) at Ambient Monitoring Stations B0480050, B0540000 and B0540050



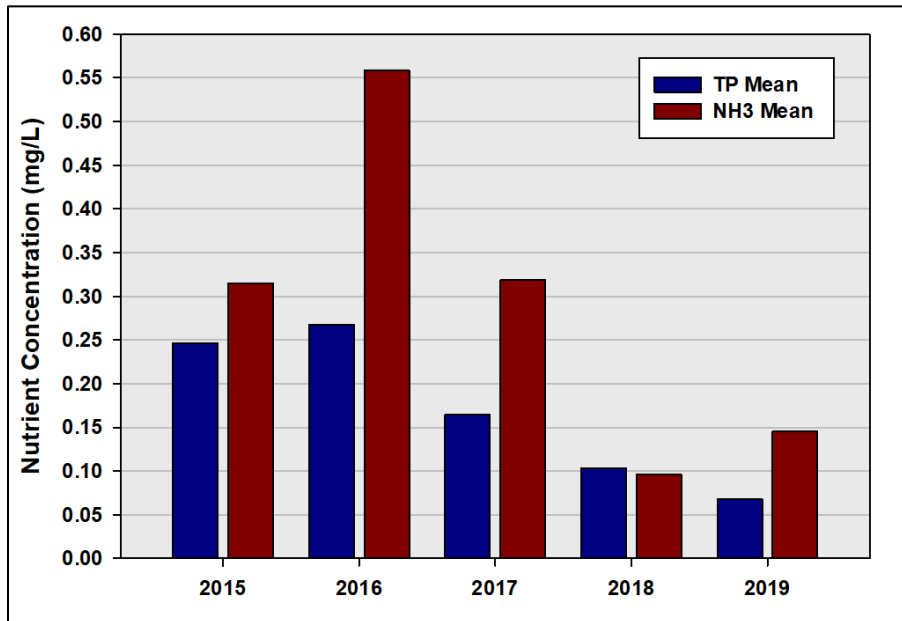
Ambient Monitoring Stations B0480050 (upstream of WWTP; black bar), B0540000 (3.4 miles downstream of WWTP; orange bar) and B0540050 (7.7 miles downstream of WWTP; blue bar) with stream flow at USGS Gage Station 0209553650 (Buffalo Creek). Note: North Buffalo Creek WWTP ceased discharging wastewater to North Buffalo Creek on October 6, 2017.

Figure 6-40: North Buffalo Creek Nitrogen Constituent Concentration at Station B0540000 between 2015 and 2019



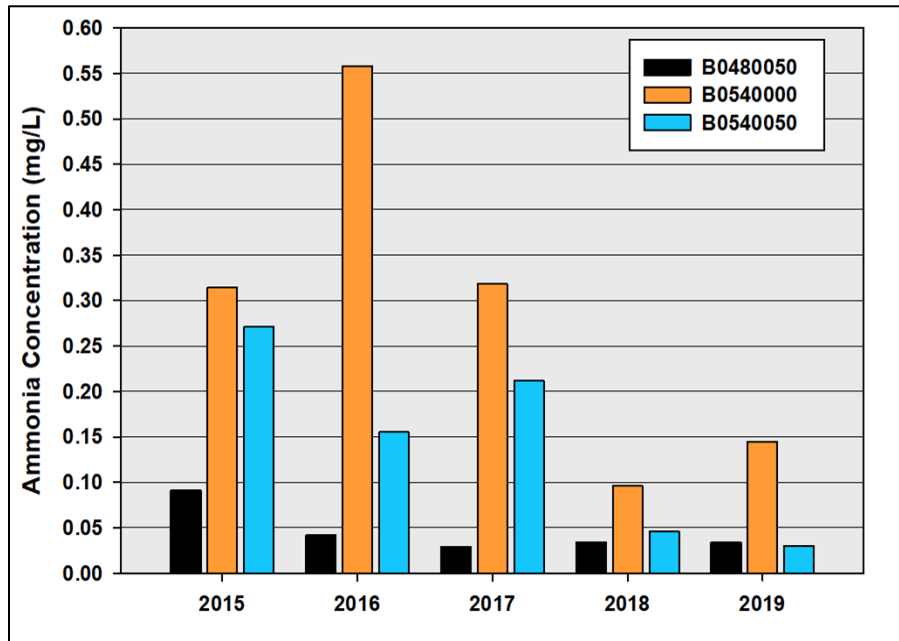
The scale break on the Y-axis is to allow for better resolution of the nitrogen concentrations post plant closure; B0540000 is about 3.4 miles downstream of the North Buffalo Creek Wastewater Treatment Plant which closed October 6, 2017.

Figure 6-41: North Buffalo Creek Total Phosphorus and Ammonia Concentration at Station B0540000



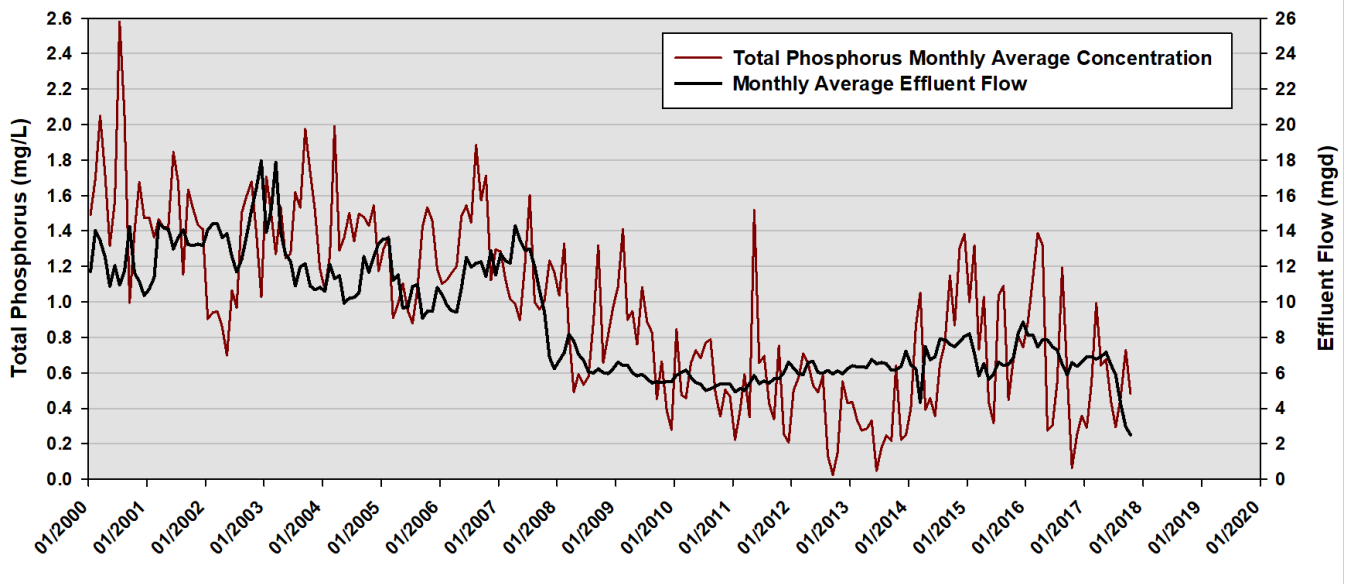
Station B0540000 is about 3.4 miles downstream of the North Buffalo Creek Wastewater Treatment Plant (Closed October 6, 2017).

Figure 6-42: North Buffalo Creek Ammonia Concentration by Ambient Monitoring Station between 2015 and 2019



B0480050 (upstream of WWTP; black bar), B0540000 (3.4 miles downstream of WWTP; orange bar) and B0540050 (7.7 miles downstream of WWTP; blue bar).

Figure 6-43: North Buffalo Creek Wastewater Treatment Plants Monthly Average Total Phosphorus Effluent Concentration and Flow Between 2000 and 2017



The lower end of North Buffalo Creek remains Impaired (2022 IR) for total copper and zinc (*Table 6-16*). The new instream dissolved metals standards were approved in 2014. The lower portion of North Buffalo Creek will remain impaired until such a time that the new dissolved standards can be assessed. When resources allow, a special study should be conducted to assess the dissolved metals concentrations throughout the North and South Buffalo Creek watershed. This should include both the upper and lower portions of the watershed.

The largest drop in the North Buffalo Creek instream total phosphorus concentration occurred in 2008 (*Figure 6-39*). This is the result of a reduction in total effluent volume discharged and a drop in the overall total phosphorus effluent concentration from the North Buffalo Creek WWTP during this same period (*Figure 6-43*). The instream total phosphorus concentration continued to decline once the treatment plant closed (*Figure 6-39*).

The instream ammonia concentration, which is a pollutant that is known to negatively impact aquatic organisms, also dropped substantially (*Figure 6-42*). The concentration at B0540000 was still elevated above the upstream background concentration but appears to have been diluted with additional drainage in the watershed above the lowest creek station (B0540050). The removal of the wastewater discharge to North Buffalo Creek will likely have a positive impact in the lower portion of the watershed. The main sources of pollutants to North Buffalo Creek are now nonpoint source related and should be addressed to continue to improve the water quality and habitat of North Buffalo Creek and to address the continued sources of fecal coliform bacteria.

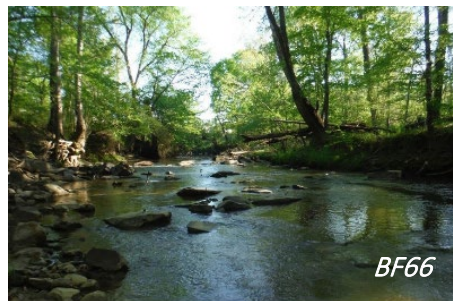
Two benthos and five fish community stations were sampled during the plan reporting period (*Figure 6-11* and *Figure 6-12*). Four of those were sampled only once. North Buffalo Creek benthic sampling site BB527 and fish community site BF64 are co-located at Lake Daniel Park. These are the upstream-most biological sampling sites that have been sampled. BB527 was sampled once in 2014 as part of a special study and rated Fair; site BF64 was sampled once in 2013 and rated Good-Fair. The project reach is highly pervious, with a shopping center on one side and a hospital campus on the other. The next site downstream is fish community site BF36, which is located on the upstream end of Latham Park. This site was sampled twice; in 2004 it rated Good-Fair and in 2009 it rated Poor. This significant decline in bioclassification between the sampling periods warrants follow-up with resampling as time and resources allow. Like the upstream sites, the sample reach is highly developed and stream buffer is sparse. Fish community site BF106, sampled once in 2004, is located on an industrial property and rated Poor. Buffers are sparse in this stretch and stormwater or wastewater ponds are located very close to the streambanks. While fish community site BF11 has slightly better buffers than upstream sites, it was also rated Poor the one time it was sampled in 2009.

Benthic community site BB407 is located in northwestern Guilford County downstream from the North Buffalo Creek Wastewater Treatment Plant.

<b>BB527*</b>	
<b>Year</b>	<b>Bioclassification</b>
2014	Fair
<b>BF64</b>	
2013	Good-Fair
<b>BF36</b>	
2004	Good-Fair
2009	Poor
<b>BF106</b>	
2004	Poor
<b>BF11</b>	
2009	Poor
<b>BB407</b>	
2008	Fair
2013	Fair
2018	Fair
<b>BF66</b>	
2003	Poor
2013	Fair
2018	Fair
*Special Study	

The site received a Fair benthic bioclassification in 2018 for the third consecutive time since 2008. Prior to that, from 1985 to 1998, the site rated Poor. Slight water quality improvements have been noted beginning in 2008 when EPT richness doubled from three taxa to six and doubled again to 12 in 2018. The NCBI (5.91) in 2018 was the lowest recorded from this station since sampling began here in 1985 and further supports slight water quality improvements. Additionally, specific conductance (129  $\mu\text{S}/\text{cm}$ ) in 2018 was nearly fourfold lower than that measured in 1998 and much lower than all years sampled (2003, 2008, and 2013). The benthic metrics and physical chemical parameters suggest slight water quality improvements; however, the sampling station continues to be dominated by a mostly tolerant benthic macroinvertebrate community. This site continues to suffer from its mostly urban catchment with high amounts of impervious surfaces associated with Greensboro.

Fish community site BF66, North Buffalo Creek at SR 2770, had a moderately diverse fish assemblage in 2018, with one fewer species than the 2013 assessment, but with a gain in overall abundance (244 in 2018 vs. 131 in 2013). There were new DWR records here in 2018 for largemouth bass and for oriental weatherfish (*Misgurnus anguillicaudatus*). This aquarium-trade loach species has also been collected from three other Haw River catchment sites in 2009 (Varnals Creek, Haw Creek and South Buffalo Creek). Species with young-of-year present in 2018 include redbreast sunfish, bluegill, flat bullhead and speckled killifish. As of the 1994 and 2018 time period, there are now 18 known fish species in this urban catchment, all of which are categorized as either intermediately tolerant or tolerant to pollution. The marginal improvements seen in 2013 persisted into 2018, with the same overall NCBI score and Fair rating in these last two assessments. However, the establishment of oriental weatherfish in the Haw River catchment is concerning. Site BF66 should be sampled again in 2023.



#### 6.6.1.3 South Buffalo Creek

South Buffalo Creek has a drainage area of approximately 45 square miles, drains a large portion of downtown Greensboro and is the receiving stream for the 56 MGD T.Z. Osborne wastewater treatment plant discharge. According to the USGS StreamStats tool (August 2021), the watershed is about 73% developed with an average impervious area of 30% (based on 2011 NLCD), which is a level high enough to result in significant measurable impacts to water quality (Schueler, 1994). There are two ambient monitoring stations (B0670000 upstream and B0750000 downstream), two benthic macroinvertebrate and three fish community stations (*Figure 6-12* and *Figure 6-16*). Monitoring at one of the benthic macroinvertebrate stations was discontinued in 2003, two of the fish community stations have been monitored twice, and the third fish community station has been monitored only once.

South Buffalo Creek has been listed as impaired for aquatic life due to conditions that impact the benthic macroinvertebrate (aquatic bugs) and fish communities (*Table 6-16* and Chapter 2 Appendix – *Land Use Land Cover for AMS and Coalition Station Watersheds*). It is also impaired due to elevated fecal coliform bacteria concentrations. The stream drains to Buffalo Creek and then to Reedy Fork which has an approved fecal coliform bacteria TMDL. The benthic and fish data continue to indicate that the aquatic life throughout this watershed is impacted by the degraded water quality. In their 2004 Basinwide

Assessment Report (BAR) the DWR biologist stated, “the segments of North Buffalo and South Buffalo creeks below the City of Greensboro’s WWTP dischargers constitute some of the worst water quality problems in the state. Conductivity values, nutrients and copper concentrations were chronically elevated in these streams” (DWQ, 2004 BAR). The influence of the T.Z. Osborne WWTP (NC0047384) discharges to South Buffalo Creek can be determined by comparing data from the two AMS stations, B0670000 which is about four miles upstream of the WWTP and captures the influence of the densely developed headwaters (~88%; 2019 NCLD development percentage) and B0750000 which is about 2.6 miles downstream of the WWTP (~76%; 2019 NCLD development percentage) (*Table 6-17*).

As previously discussed, in 2013, the city requested an expansion from 40 MGD to 56 MGD in order to accommodate the additional waste flow from the North Buffalo WWTP (16 MGD). To meet a total nitrogen reduction schedule as a result of the Jordan Lake point source nutrient reduction rules, a treatment plant upgrade was included as part of the expansion plans. South Buffalo Creek is an effluent-dominated stream with the wastewater discharge representing 96.7 % of the instream waste concentration (IWC) at 40 MGD and 97.6% IWC at 56 MGD ([2014, NPDES permit Fact Sheet](#)).

Instream data in this watershed runs through 2019. Future data will include instream water quality conditions reflective of the upgraded wastewater treatment plant. The next biological assessment is likely to occur in 2023, at least one full year after the upgrades to the T.Z. Osborne facility is complete. It is recommended that DWR continue to assess the benthic macroinvertebrate station downstream of the treatment plant as conditions may begin to improve due to the reduction of nutrient loads as well as their efforts to address other pollutants of concern in their effluent.

High fecal coliform bacteria concentrations are recorded at both ambient stations in South Buffalo Creek (*Figure 6-44*). The sources are likely similar to those described in North Buffalo Creek and Reedy Fork and vary depending on wet or dry conditions. Between 2000 and 2019, the higher yearly mean and yearly geomean fecal coliform bacteria concentrations are evenly distributed between the two stations (B0670000 and B0750000) and are not directly correlated with flow (*Figure 6-44*). In seven of the 20 years of data presented in *Figure 6-44*, the high mean and geomean concentrations do not coincide (2000, 2002, 2003, 2012, 2014, 2015 and 2019). While the fecal coliform bacteria standard applies specifically to samples collected as 5-in-30 (five samples collected within a 30-day period), yearly averages from monthly data can provide a snapshot of the overall general water quality conditions in the watershed. The standard is no more than 20% of the 5-in-30 samples greater than 400 cfu/100mL or a geomean not greater than 200 cfu/100mL. The red lines in the graphs represent these two criteria but are not directly applied to yearly means or geomeans. *The City of Greensboro and watershed stakeholders should implement BMPs in this watershed to reduce bacteria from entering surface waterbodies from stormwater runoff and collection system sources.* Reductions in bacteria loading from the South Buffalo Creek watershed will help achieve the downstream TMDLs.

The impacts from nonpoint sources of pollution are apparent from the flow separated graphics as the average fecal coliform bacteria levels are approximately 3924 cfu/100 mL during high flows ( $\geq 28.7$  cfs) while average values are approximately 686 cfu/100 mL at normal flows and 191 cfu/100 mL during lower flow periods ( $\leq 6.4$  cfs) (*Figure 6-45*). The low flow concentration is 95% lower than the average high flow

concentrations. This strongly suggests that stormwater runoff is contributing a large percentage of the fecal loading in South Buffalo Creek.

The instream nitrogen and phosphorus concentrations in South Buffalo Creek are significantly higher at the downstream station (B0750000) below the T.Z. Osborne wastewater treatment plant (*Table 6-17*). Concentrations were generally 6 to 15 times higher in total nitrogen and 5 to 26 times higher in total phosphorus (*Figure 6-46*). The wastewater total nitrogen load to South Buffalo Creek increased through 2019 with a maximum load of 1,537,981 pounds in 2019 and dropped to 518,041 pounds in 2022 (*Figure 6-22* and *Table 6-19*). Total phosphorus wastewater loading peaked in 2021 at a yearly load of 106,549 pounds, below their yearly TP allocation (*Figure 6-23* and *Table 6-19*).

*Table 6-19 T.Z. Osborne WWTP Annual Total Nitrogen and Total Phosphorus Jordan Lake Allocation and their Load to South Buffalo Creek between 2019 and 2022*

T.Z. Osborne WWTP NC0047384	Allocation lbs/yr	Percentage of Haw River Allocation	Percentage of Jordan Lake Allocation	2019 lbs/yr	2020 lbs/yr	2021 lbs/yr	2022 lbs/yr
<b>Total Nitrogen</b>	891,272	57.7%	44.9%	1,537,981	1,236,827	586,838	518,041
<b>Total Phosphorus</b>	112,044	57.7%	49.2%	67,211	75,546	106,549	52,737

Jordan Lake nutrient strategy (15A NCAC 02B .0262)

The yearly average effluent discharge flow has increased from 19.5 MGD in 2000 to 23.8 MGD in 2010 and to 36.2 MGD in 2020. The T.Z. Osborne facility has been treating 100% of Greensboro’s wastewater since October 6, 2017, and expanded to treat up to a monthly average of 56 MGD. The total nitrogen load began to decline in 2021 in response to completing the treatment plant expansion and upgrade which will decrease the load to no more than 891,272 lbs/yr nitrogen to meet the Jordan Lake nutrient strategy (*Figure 6-22* and *Table 6-19*). At the full 56 MGD permitted flow this is an equivalent effluent concentration of 5.23 mg/L TN and 0.66 mg/L TP. Greensboro has 57.7% of the TN and TP Haw River Arm of Jordan Lake allocation and 44.9% of the whole lake TN allocation and 49.2% of the TP allocation (*Table 6-19*). It is estimated that the TN and TP transport factor for T.Z. Osborne to Jordan Lake is 45%. As part of the NC Collaboratory research studies on Jordan Lake (Luettich et al.,2019) reported that under certain climate conditions, water from the Haw River was forced upstream into the New Hope Creek arm of the lake, delivering nutrients and other potential pollutants into the system. This was not well understood prior to the special study which took place between May 2017 and January 2019. For more detail on the results from the NC Jordan Lake Collaboratory Studies see Jordan Lake Study Reports here: <https://nutrients.web.unc.edu/resources/>.

Figure 6-44: South Buffalo Creek Annual Mean and Geomean Fecal Coliform Bacteria Concentrations and Reedy Fork Flow (USGS Gage 02094500) at Ambient Monitoring Stations B0670000 and B0750000

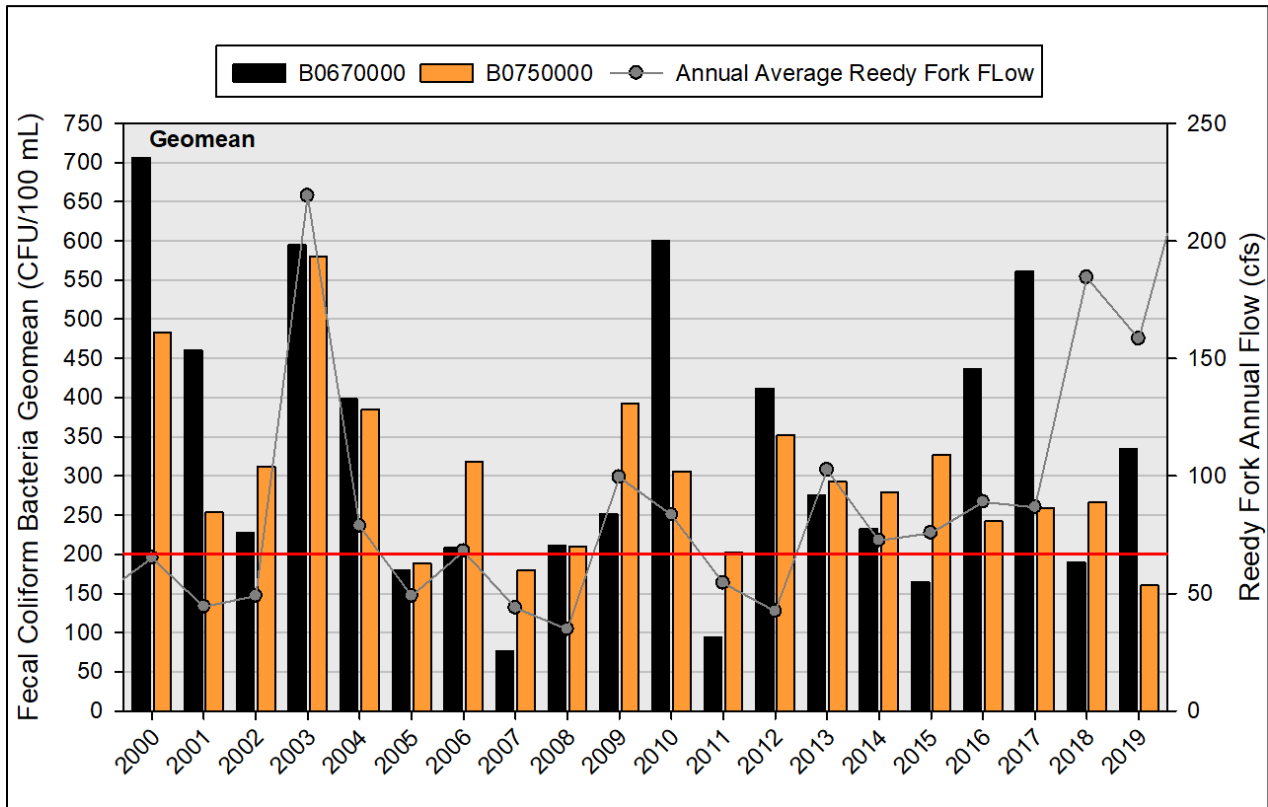
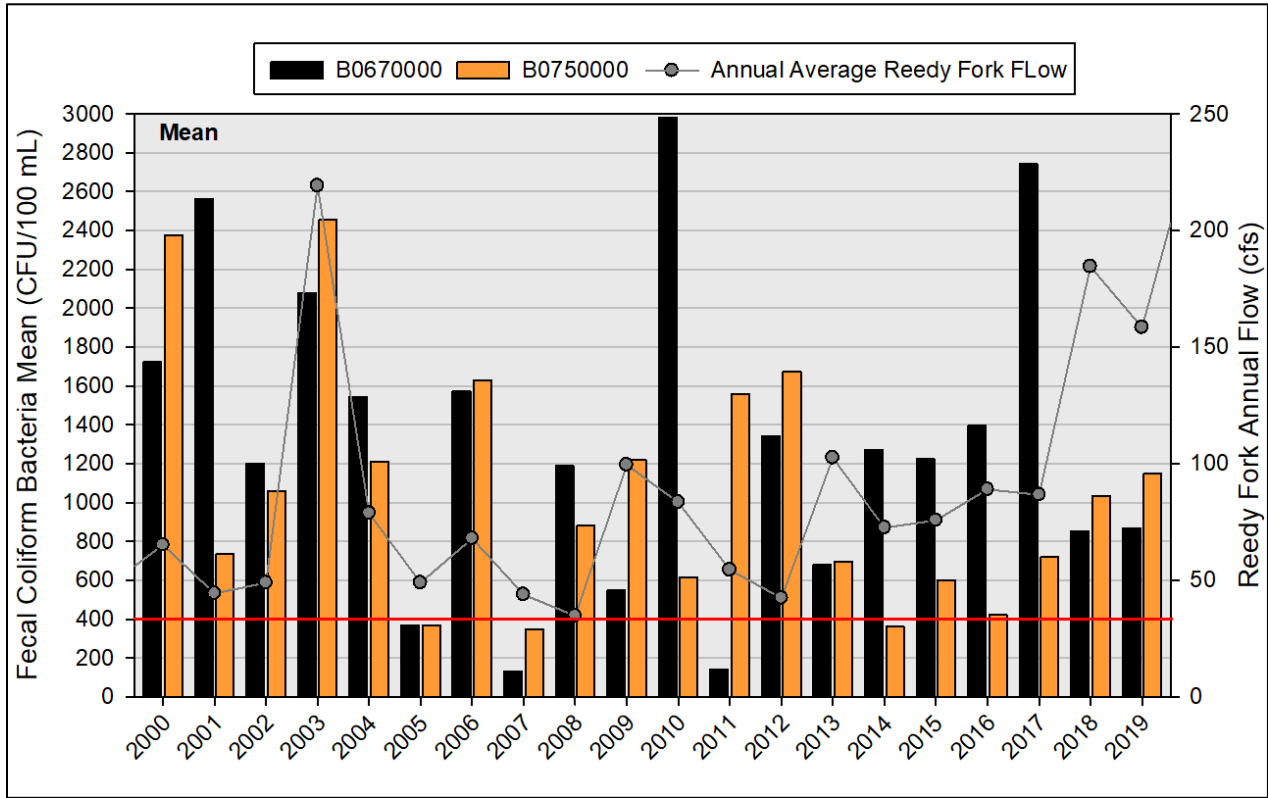
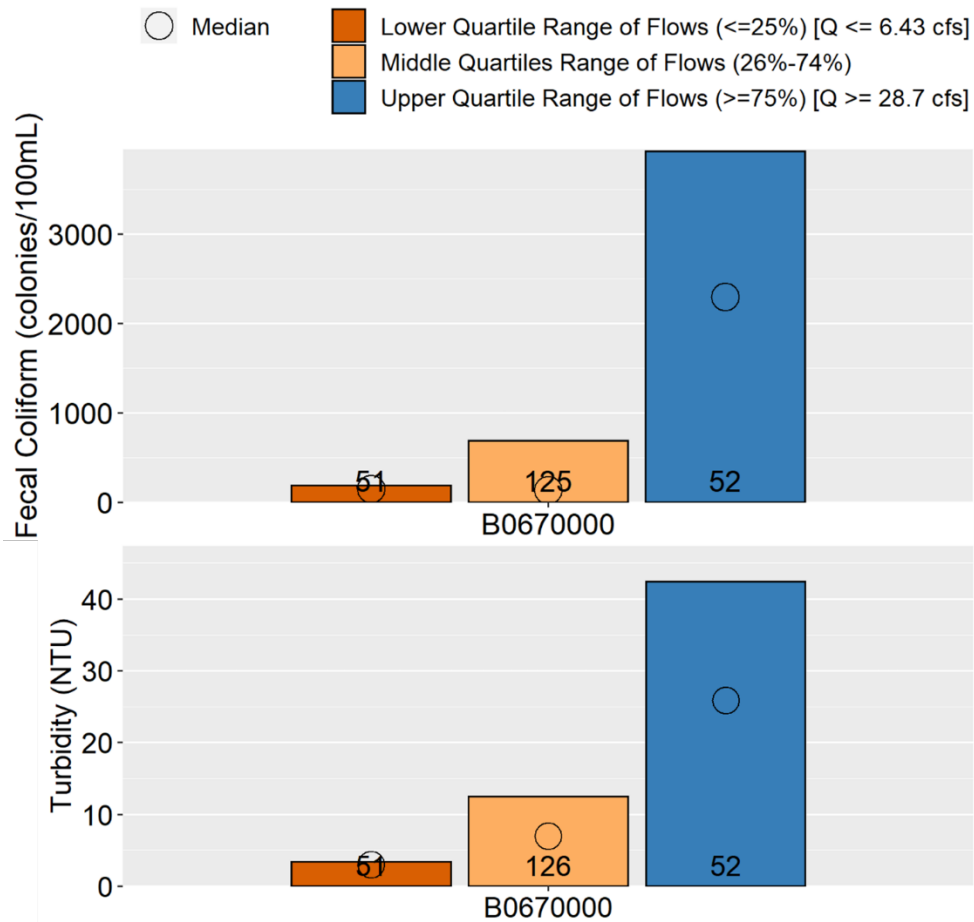
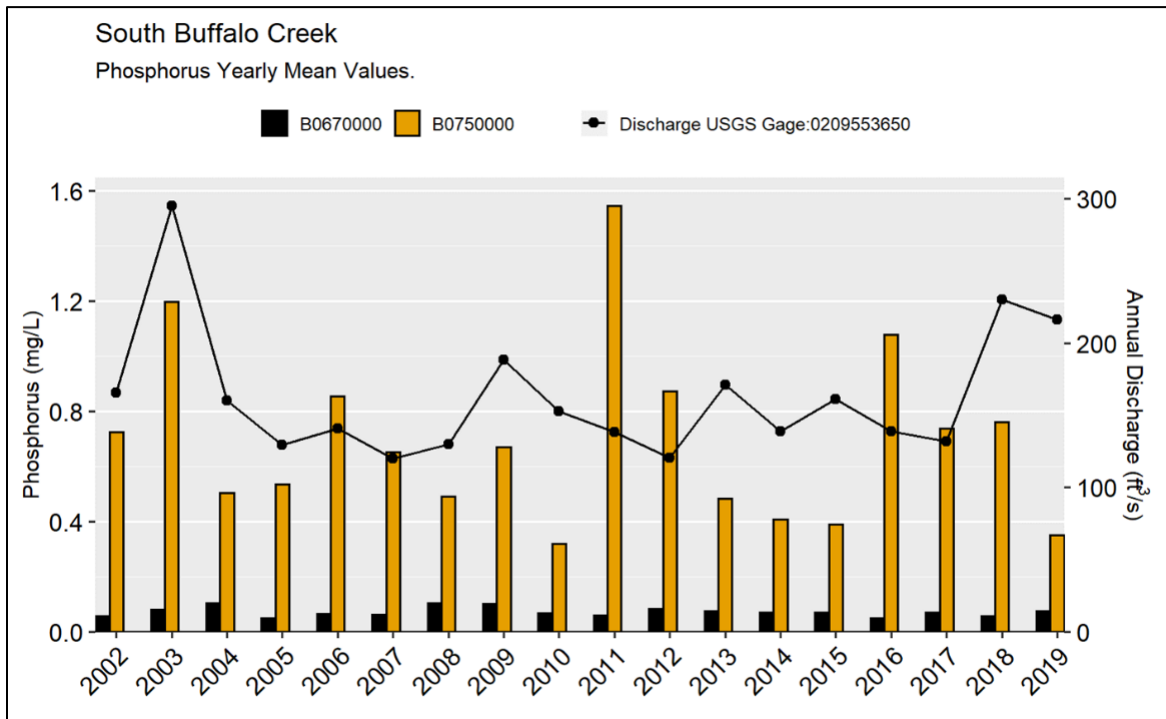
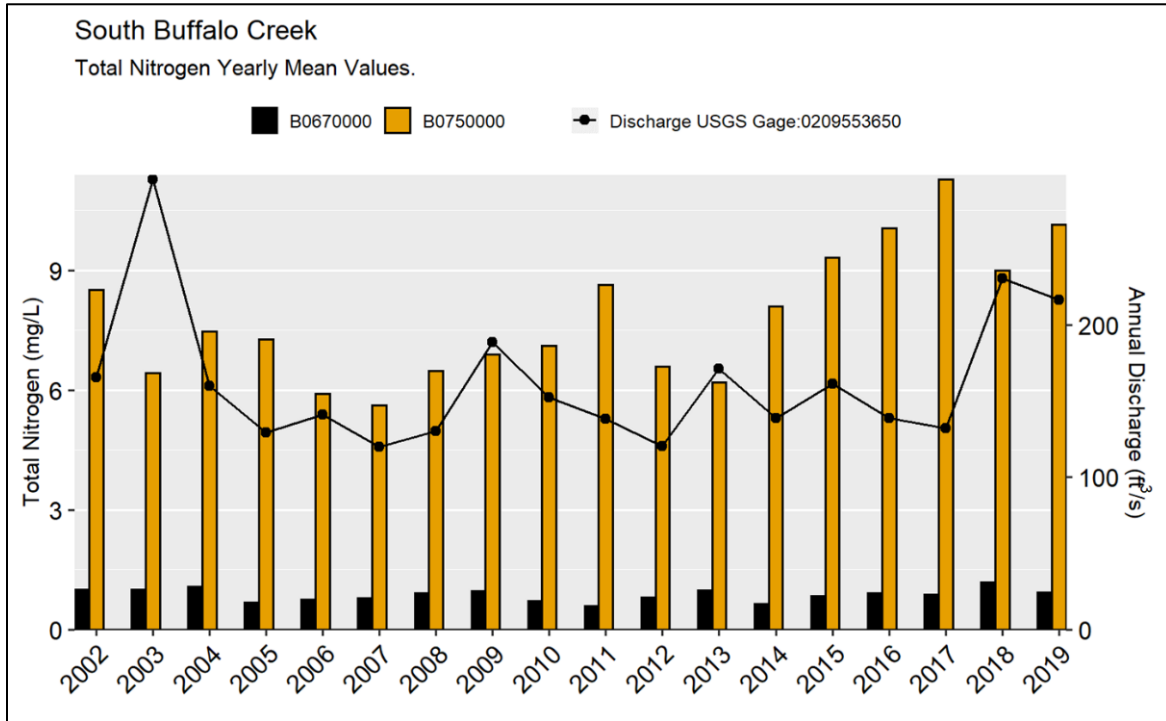


Figure 6-45: South Buffalo Creek Flow Separated Mean and Median Concentrations for Fecal Coliform Bacteria and Turbidity at Station B0670000 (2002-2020) and Co-located USGS Gage Station 02095000 (1998-2020).



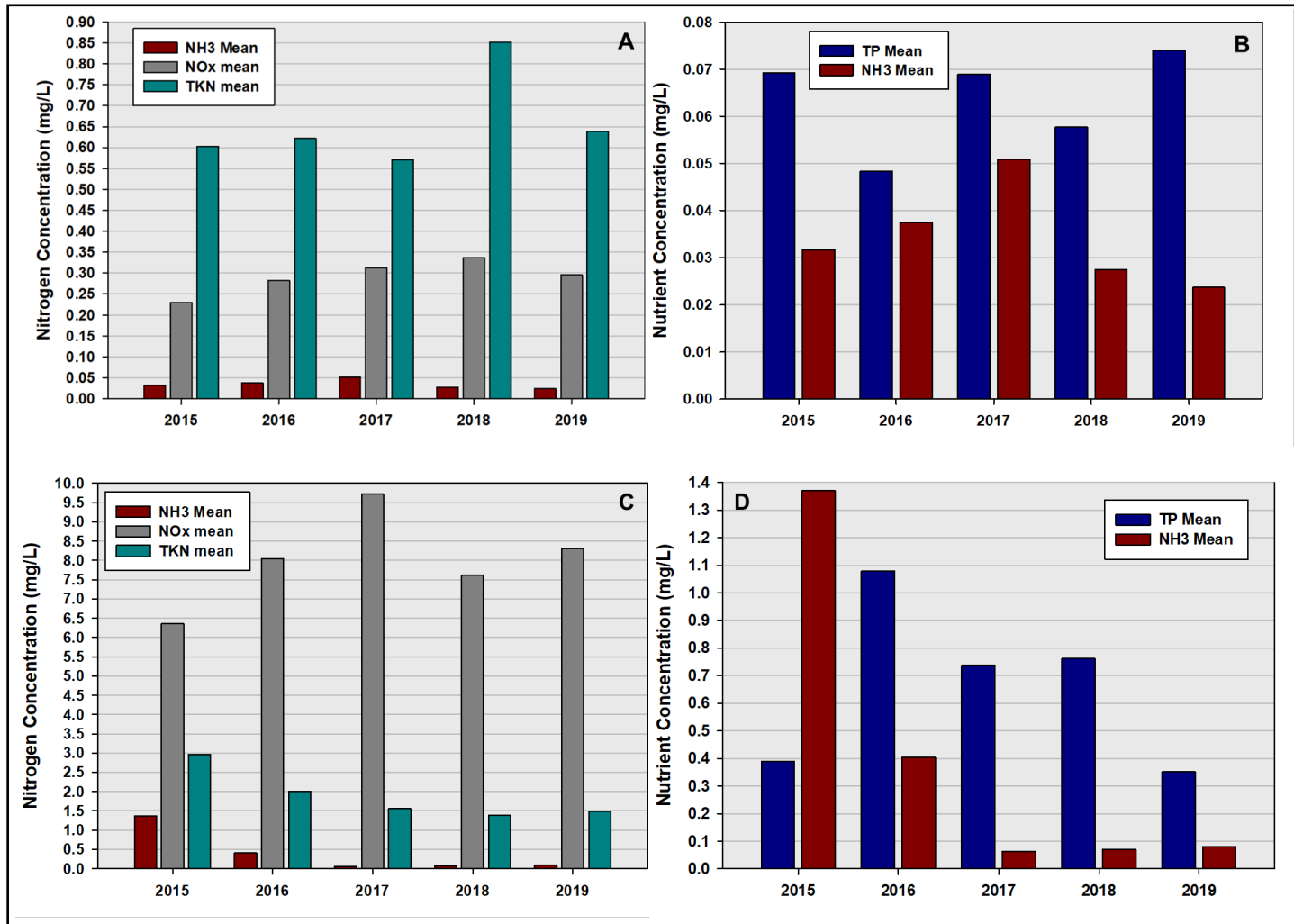
Numbers on bar graph are the number of water quality samples that fall into that specific flow bin from the 2002-2020 dataset.

Figure 6-46: South Buffalo Creek Instream Total Nitrogen and Total Phosphorus Concentrations (mg/L) at Ambient Monitoring Stations B0670000 and B0750000



Ambient Monitoring Stations B0670000 (Upstream of WWTP; black bar) and B0750000 (Downstream of WWTP; orange bar) with Stream Flow at USGS Gage Station 0209553650 (Buffalo Creek). Note: As of October 6, 2017, all of Greensboro's wastewater is treated at the T.Z. Osborne WWTP and discharged into South Buffalo Creek.

Figure 6-47: South Buffalo Creek Nutrient Constituent Concentration at Stations B0670000 (A and B) and B0750000 (C and D) between 2015 and 2019



Note the scale differences between all the graphs. Station B0670000 is ~ 4 miles upstream and B0750000 is ~ 2.6 miles downstream of the T.Z. Osborne Wastewater Treatment Plant.

Over the period between 2015 and 2019, the yearly average instream total nitrogen concentration below the treatment plant (B0750000) has been between 9 and 11.5 mg/L where upstream the concentration was between 0.8 and 1.2 mg/L (*Figure 6-46*). Over this same time period (2015-2019), the total nitrogen concentration upstream (B0670000) of the wastewater treatment plant was composed of twice as much organic-nitrogen (TKN-NH<sub>3</sub>) to inorganic-nitrogen (NO<sub>x</sub> + NH<sub>3</sub>) and relatively low ammonia and total phosphorus concentrations (*Figure 6-47*). In comparison, the total nitrogen concentration downstream of the wastewater treatment plant is composed of mainly NO<sub>x</sub>, a classic signature of wastewater discharge. The NO<sub>x</sub> is 4 to 6.5 times higher than the organic-nitrogen concentration and 23 to 31 times higher than upstream concentrations. The TKN, total phosphorus and ammonia concentrations are also higher below the wastewater treatment plant (*Figure 6-47*). The higher ammonia concentration in 2015 was the result of wastewater treatment plant issues which are described in detail above (6.6.1.1; *Figure 6-34*). The high ammonia concentrations were conveyed downstream as peaks in ammonia concentrations were recorded at several downstream stations during that timeframe (*Figure 6-32* and *Table 6-18*).

DWR conducted screening level seasonal and non-seasonal Mann-Kendall trend tests at 95% confidence for monitoring data collected from 2000 to 2019 for both ambient water quality stations (*Table 6-17*). The upstream station B0670000 showed a non-seasonal increase in TKN between 2010 and 2019. The downstream station, B0750000, showed a seasonal increase in NO<sub>x</sub> for 2000-2019 and 2010-19 and TKN for 2000-2019. There was a decreasing non-seasonal trend in TP between 2000 and 2019 and a decreasing seasonal trend in fecal coliform bacteria for 2000-2019. The Reedy Fork subwatershed had the highest overall mean TN, TP, NO<sub>x</sub> and NH<sub>3</sub> instream concentrations for the 2022 IR period (2016-2020) due to the loading from Greensboro's WWTP to North and South Buffalo creeks (*Table 6-10*). The conveyance of these nutrients downstream can be seen in the Haw River mainstem where the TN and TP instream concentrations increase from 1.15 and 0.09 mg/L, respectively, upstream (B0210000) of Reedy Fork to 3.47 and 0.23 mg/L, respectively, downstream (B1020000) of the confluence with Reedy Fork. For more details on this segment of the mainstem Haw River conditions, see section 6.6.4 in the Back Creek watershed writeup.

Conductivity is useful as a general measure of water quality, according to the [EPA Indicators website](#). DWR and the monitoring coalition collect specific conductance or conductivity data at each ambient monitoring station one to two times per month because it is a good proxy for understanding water quality and pollutant contributions in a watershed. A significant change in conductivity or elevated levels are generally accepted as an indicator of a discharge of pollutants into surface waters. South Buffalo Creek has very high conductivity levels at both stations with the downstream station below the treatment plant 1.5 to 2.8 times higher between 2015 and 2019, ranging in conductivity between 468 to 670 µS/cm (*Figure 6-48*). There has not been a major shift in the conductivity levels over the years and the five-year means helps to see the general tendency over time without the noise of the yearly variability (*Figure 6-49*). South Buffalo Creek is clearly impacted by both point and nonpoint sources of pollutants.

Figure 6-48: South Buffalo Creek Specific Conductance (Conductivity) at Stations B0670000 (~ 4 miles upstream of WWTP) and B0750000 (~ 2.6 miles downstream of WWTP) between 2015 and 2019.

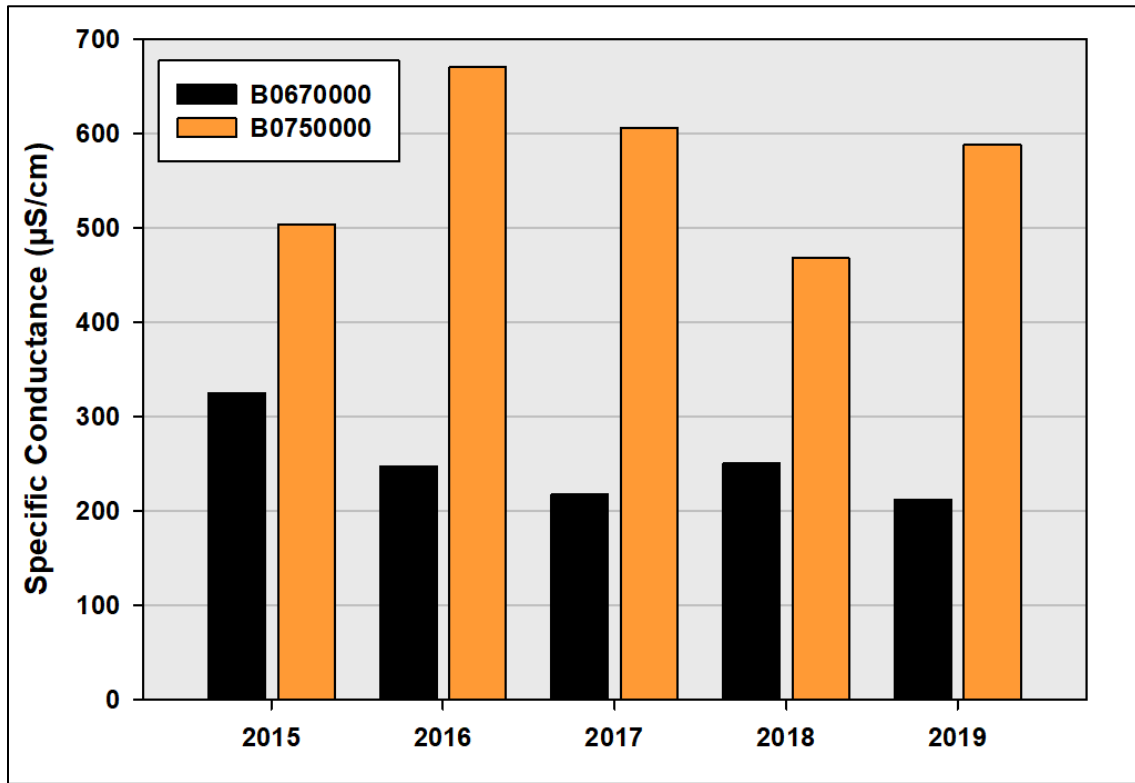
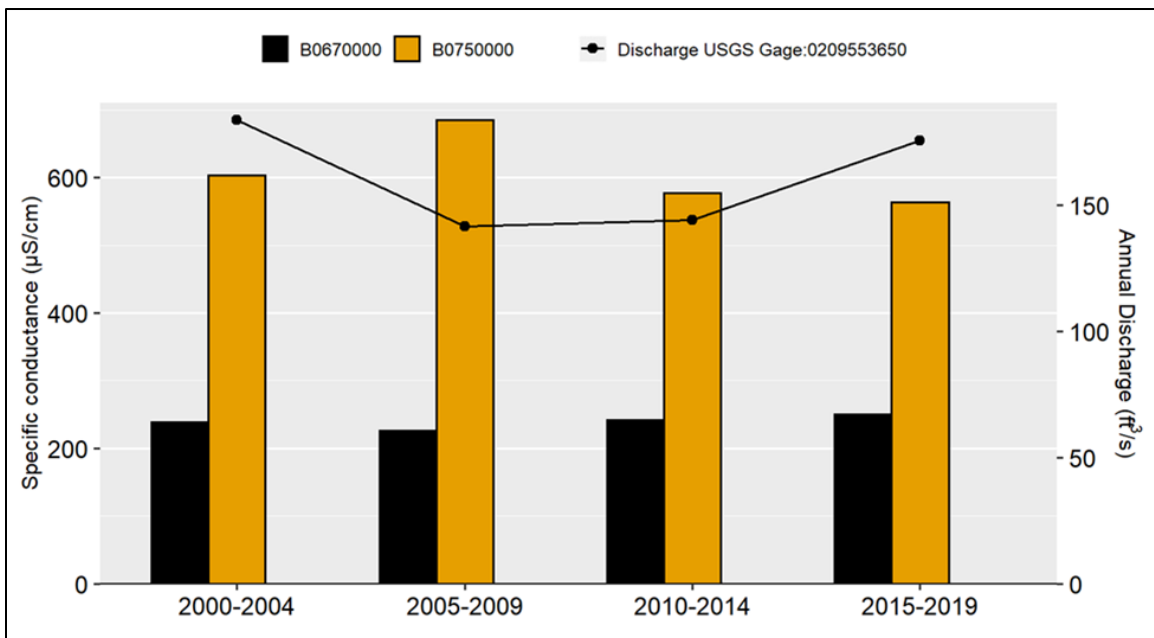


Figure 6-49: South Buffalo Creek Five-Year Average Specific Conductance (Conductivity) at Stations B0670000 and B0750000 between 2000-2019 with Stream Flow at USGS Gage Station 0209553650 (Buffalo Creek).



Turbidity is used as a general water quality indicator. High instream turbidity levels can have a negative impact on the aquatic health of the ecosystem. Urban streams generally receive a lot of stormwater runoff, which can carry sediment and other pollutants into the streams. High flow/runoff events can also cause instream bank destabilization and erosion, resulting in high internal sediment loading to the system. Implementation of stormwater BMPs that both capture pollutants and control stormwater volume is critical to slow the discharge and help dissipate the impacts to these urban stream networks. Stream banks with established riparian buffers also slow runoff and absorb pollutants while holding the soils in place to limit stream bank erosion that often occurs during high flow events. The turbidity levels in South Buffalo Creek have remained rather consistent looking at the overall trend of the five-year averages (*Figure 6-50*). The higher individual yearly averages shift between the two stations with the upstream concentration higher 55% of the time (*Figure 6-51*). The number of times a sample exceeds the instream water quality turbidity standard of 50 NTU or percent exceedance varies from year to year and from station to station and does not appear to be directly related to the annual average flow (*Figure 6-51*). This is likely influenced more by how often surface water monitoring occurs in close proximity in time to when a storm occurred. A single rain event that can cause a spike may not be captured by looking at the overall yearly flow summaries. Additional flow related analysis would be needed to make the link between turbidity and flow in this watershed.

*Figure 6-50: South Buffalo Creek Five-Year Average Turbidity Concentrations at Stations B0670000 and B0750000 with Stream Flow at Buffalo Creek USGS Gage Station 0209553650.*

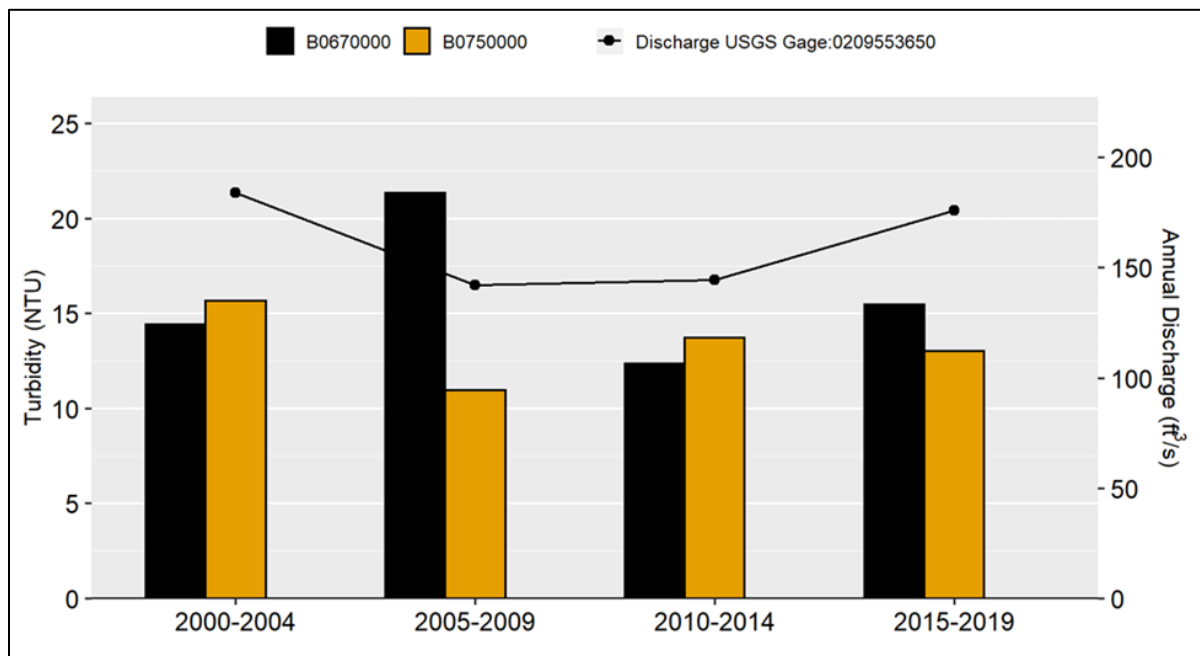
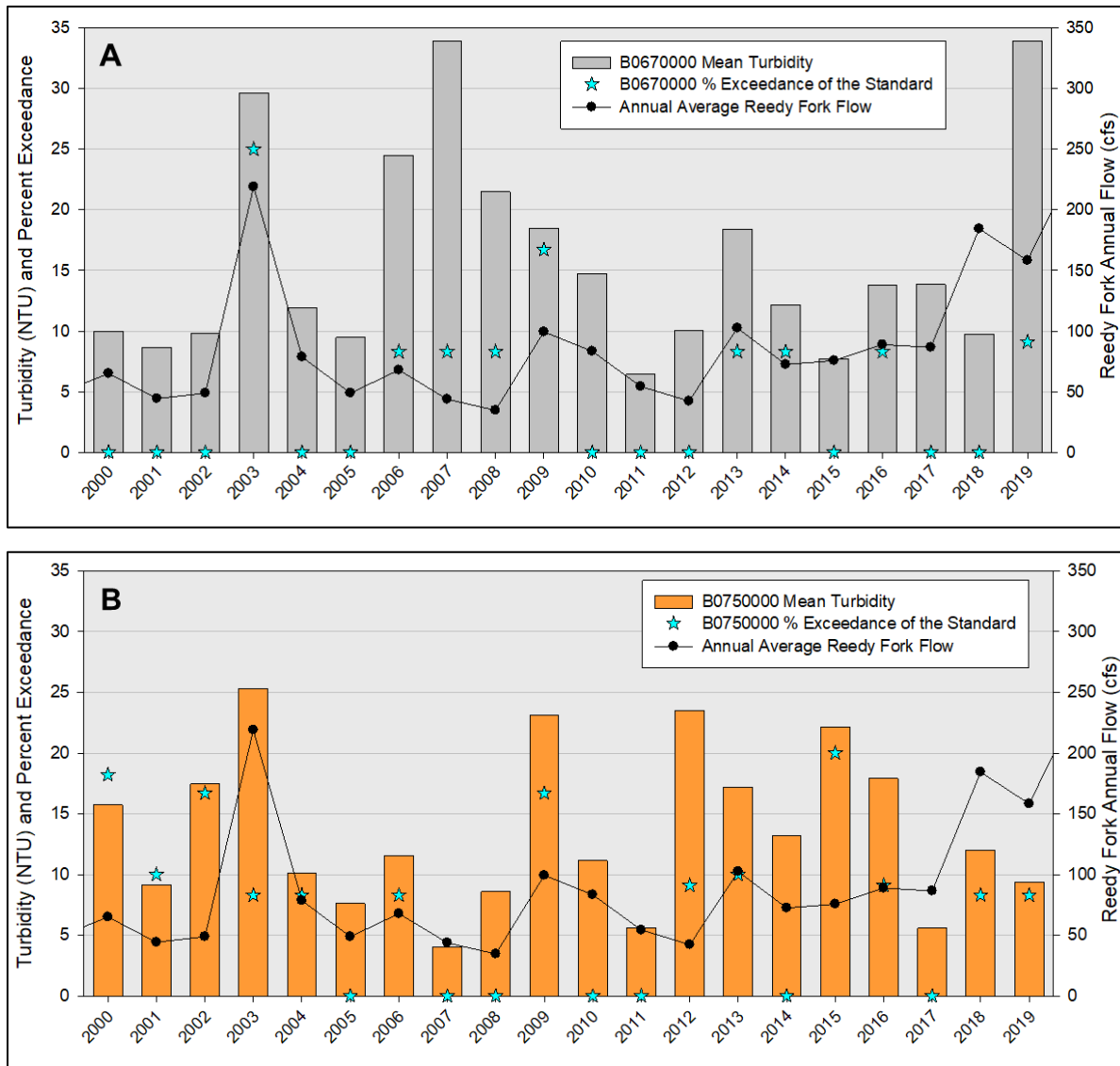


Figure 6-51: South Buffalo Creek Annual Average Turbidity Concentration and Percent Exceedance of the Standard (50 NTU) at Stations B0670000 (A) and B0750000 (B) with Stream Flow at Reedy Fork, USGS Gage Station 02094500.



The urban land use in the South Buffalo Creek catchment is also influencing biological communities in the stream. The stream meanders east through a highly developed landscape (City of Greensboro) and most of the baseflow in South Buffalo Creek downstream of the T.Z. Osborne WWTP is due to the 56 MGD outfall. As a result of these combined factors, fish and benthos sampling in this catchment has mostly resulted in ratings of Fair or Poor.

Fish community site BF113 (in Hunter Hills Park at Merritt Drive) is the furthest upstream biological sampling site. It was last sampled in 2009 and rated Fair at that time. While the sampling site is located in a fairly well buffered section of stream in the park, the buffer is narrow, and the surrounding landscape appears to be mowed and managed. Land use above the site is highly urbanized and the stream is flanked on both

sides by substantial amounts of impervious surface, including a large church parking lot that spans the entire sampling reach and a four-lane road at the downstream terminus of the reach. Similarly, Fish community site BF18, approximately 8.5 stream kilometers downstream of BF113, was last sampled in 2009 and rated Fair at that time. Like the upstream site, the sample reach of BF18 appears to be well buffered but is surrounded by urban and industrial development with a high amount of impervious surface that is likely affecting habit and water quality in this reach. A prior rating of Good-Fair in 2004 indicates that the site may still have been recovering from drought at the time of the 2009 sampling or there was a decline in habitat or water quality. Both BF113 and BF18 should be resampled as time and resources allow.

Benthic Community Site BB444 was last sampled in 2003, when it rated Fair. The sample reach appears to be devoid of buffer and is within 300 feet of I-40. Specific conductance measured 224.0  $\mu\text{S}/\text{cm}$ , indicating degraded water quality, and substrate was noted as 100% sand. Both of these factors, along with the developed nature of the watershed and lack of buffer in the sample reach, likely contributed to the low bioclassification.

Fish community site BF73 is approximately 10km downstream of BB444 and has rated Poor since sampling began at this station in 1994. In 2013, field staff noted elevated conductivity, tires, urban debris, lack of instream habitats and a hydrologically flashy system. This site received one of the lowest habitat scores of any fish community site in the basin in 2013. Although riparian zones were mostly forested with some side snags present, shallow sandy runs were prevalent, riffles were absent, and bank erosion was noted. BF73 also had the second highest specific conductance measurements of any fish community site in the basin in 2013 (ranging from 197-266  $\mu\text{S}/\text{cm}$ ) which was a result of stormwater runoff. In 2013, the fewest species ( $n=7$ ) and lowest NCIBI score (24) of any site in the basin was collected and the number of fish declined by 60% between 2003 and 2013 (293 vs. 118). Only 13 species are known from the site, including two nonindigenous species. Four of the nine species (golden shiner, snail bullhead, pumpkinseed and warmouth) have not been collected since 1994; dominant species are the tolerant eastern mosquitofish and redbreast sunfish. Staff noted that due to the consistent poor quality of the site, monitoring should be reduced to once every 10 years or eliminated altogether.

BF113	
Year	Bioclassification
2004	Poor
2009	Fair
BF18	
2004	Good-Fair
2009	Fair
BB444	
2003	Fair
BB406	
2003	Poor
2008	Fair
2018	Fair
BF73	
2013	Poor
2003	Poor



Benthic community site [BB406](#), which is co-located with ambient monitoring site B075000, is approximately 0.25km downstream of the 56 MGD discharge from the city of Greensboro's WWTP discharge. Severe erosion, a mostly homogenous shifty sand substrate, and increased sedimentation were noted within the sampling reach. This site received Poor benthic bioclassifications beginning in 1985 and through 1998. With the exception of the 1998 sample, which was taken immediately after a fish kill, EPT taxa richness has been gradually increasing since 1993 suggesting an improvement in water quality. EPT taxa richness gradually increased in the stream throughout basinwide cycles after 1998 and the NCBI gradually dropped from 2003 to 2018 when the site received Fair benthic bioclassification. The NCBI (6.88) was the lowest recorded at this sampling station and suggested slight water quality improvements in this reach of South Buffalo Creek. However, it appears that the 2018 sample of this site may have been taken in the wrong location, in the same location as Monitoring Coalition site B0670000, which is upstream of the T.Z. Osborne WWTP. This assumption is based partly on the significantly lower specific conductance measurement taken in 2018 when compared to other sampling years (138.8  $\mu\text{S}/\text{cm}$  in 2018 vs. 264.0-815.0  $\mu\text{S}/\text{cm}$  in past sampling years). This benthic macroinvertebrate sampling station is listed on the draft 303(d) list for biological integrity. Both Benthos community site BB444 as well as BB406 should be resampled during the 2023 sampling cycle.



**Ryan Creek and UT Ryan Creek**

Ryan Creek and its unnamed tributary are in a highly developed (90%) watershed with highly concentrated single and multi-family residential and commercial and industrial development. Buffers are sparse and are almost non-existent on the UT. The headwaters of Ryan Creek are impounded in an old farm pond and the stream runs under the I-85 and US 421 interchange in the headwaters. The stream flows northeast to its confluence with South Buffalo Creek. Several sites on the UT and one site on the mainstem of Ryan Creek were sampled as part of a special study in 2016; all the sites received a bioclassification of Poor and the stream is impaired for its entire length for benthos. Field reports show that instream habitat at each site was dominated by sand and conductivity at each site was elevated, as is typical in streams with highly developed watersheds. Potential sources of pollution include residential and industrial development, road runoff and sedimentation.

BB533*	
Year	Bioclassification
2016	Poor
BB534*	
2016	Poor
BB535*	
2016	Poor
BB536*	
2016	Poor
BB537*	
2016	Poor
*Special Study	

*6.6.1.4 Reedy Fork Watershed Summary*

*Best management practices to address nutrients, fecal coliform bacteria, turbidity/sedimentation and volume control are necessary to improve water quality throughout the Reed Fork watershed.*

The upper portion of Reedy Fork is impacted by a mixture of urban and rural land use contributions. The increase in development throughout this watershed appears to be driving the benthic macroinvertebrate community to a more pollution tolerant species composition. The reservoirs are capturing a large portion of the headwater nutrients, resulting in eutrophic conditions throughout most of the summer growing season (*Figure 6-18*). The lower portion of Reedy Fork is impacted both by the nonpoint source urban runoff and by the NPDES point source and wastewater collection system as seen by the increase in nutrients below the discharge points as well as the studies that identified sources of fecal coliform bacteria.

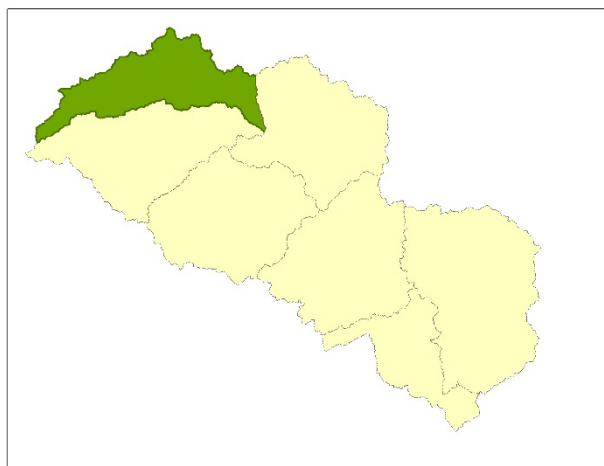
North Buffalo Creek should continue to show water quality improvements as a result of removing the wastewater discharge from the creek, stormwater implementation measures taking place to address the fecal coliform bacteria TMDL and steps taken by the city to address the Jordan Lake water quality concerns. South Buffalo Creek and the lower portion of Reedy Fork below the confluence with Buffalo Creek will also begin to see improvements as the result of the T.Z. Osborne WWTP nutrient upgrades and the reduction in the nitrogen loading needed to address Jordan Lake conditions. The resulting decline in nitrogen should be captured in data from mid-2021 and beyond. *Addressing water quality concerns in Jordan Lake will also result in improved water quality conditions locally in the Reedy Fork watershed.*

Publicly Owned Treatment Works (POTWs) must work with DWR to determine if their Pretreatment Program is sufficiently evaluating indirect dischargers to protect against accepting waste with potential emerging contaminants.

### 6.6.2 Headwaters Haw River Watershed (0303000202)

Includes: Haw River, Troublesome Creek & Little Troublesome Creek

The headwaters of the Haw River watershed are in the piedmont ecoregion and include the headwaters of the Haw River, Troublesome Creek and Little Troublesome Creek, which are strongly affected by the geology and the highly erodible sandy soils in the upper and western portions of the watershed. Low flows in these headwater streams may influence the benthic macroinvertebrate and fish community ratings. The biological monitoring stations were primarily affected by nonpoint sources of runoff, reflecting the influence of sedimentation on habitat quality (DENR, 1999).



The geology transitions from sandy soils to rocky substrate in the lower portions of Troublesome Creek and Little Troublesome Creek as they flow into the Haw River and as the Haw River flows out of the southeast corner of Rockingham County.

The Haw River throughout the Headwater Haw River watershed has relatively wide intact riparian buffers. In 2019, forest represented the largest land use at 45%, followed by agriculture at 31% and development at 15% (see the Chapter 2 Appendix *Land Use Land Cover for AMS and Coalition Station Watersheds* table;

station B0210000, 2019 NLCD). The impervious area was determined to be only 3.2%. There have not been a lot of land use changes throughout this subwatershed since 2011. This watershed, as a whole, had the lowest overall instream nitrogen (TN - 0.98 mg/L) and phosphorus (TP - 0.06 mg/L) concentrations as well as turbidity (12.9 NTU) throughout all of the HUC-10 watersheds in the Haw River subbasin between 2016 and 2020 (*Table 6-10*).

Troublesome Creek is a 55 square miles water supply III (WS-III) subwatershed with two reservoirs owned by the City of Reidsville, Lake Hunt and Reidsville Lake. Since 2003, these reservoirs have been classified as eutrophic using the NCTSI (North Carolina Trophic State Index) (*Figure 6-52*; additional lake details below). Reidsville Lake is the city's drinking water reservoir and has strict zoning laws. Activities are limited around the two lakes with 100-foot buffers and there are 50-foot buffers on all flowing streams.

The headwaters of Little Troublesome Creek start in the Town of Reidsville which encompasses the upper 5 square miles of the watershed and is the most densely populated section of the Headwater Haw River watershed (0303000202). According to the USGS Streamstats tool, this segment was 77% developed with 22% impervious land area (USGS Streamstats Assessment 2011 NLCD at confluence with UT to Little Troublesome Creek near Industrial Drive 9/21/2021).

As of 2022, there are one major and eight minor NPDES wastewater discharge facilities permitted for 7.628 MGD; six AFOs permitted for 4,965 head count and 1,794,060 lbs live weight; 566 acres of non-discharge wastewater, reclaimed water and residual solids land application fields; and 15 NPDES and six state stormwater facilities. The Town of Reidsville operates the only major wastewater treatment plant in the watershed (Reidsville WWTP, permit NC0024881). AFO facilities include four state cattle, one state swine and one animal individual state facility. More than 500 acres of permitted residual solids land application fields are associated with the City of Reidsville (WQ0002376). The City of Eden RLAP (WQ0003035) is associated with 32.8 acres of residual solids land application fields and there are 24 acres of reclaimed water fields associated with the Oak Ridge Commons WWTP (WQ0019755). There is also one single-family NPDES discharger in this watershed permitted for 450 gpd.

Reidsville WWTP (NC0024881) is permitted to discharge 7.5 MGD into the Haw River below the confluence with Little Troublesome Creek. Conditions in the lower portion of Little Troublesome Creek have improved since Reidsville's WWTP discharge location was moved to the Haw River in November 1998 to provide for greater dilution (NC DWQ, 2004 BAR). The Reidsville WWTP is subject to the Jordan Lake Water Supply Nutrient Strategy (15A NCAC 02B .0262) which requires a nitrogen and phosphorus TMDL reduction goal of 8% and 5%, respectively, from the 1997-2001 baseline load. Reidsville received a total nitrogen (TN) allocation of 120,674 lbs/yr (effective January 1, 2016) and 15,169 lbs/yr total phosphorus (TP) (effective January 1, 2010) (*Table 6-20*). In June 2016, the Reidsville WWTP facility completed a plant upgrade, which did not result in an expansion of flow. Modifications included changing aeration from mechanical surface blowers to bubble diffusion, which ultimately eliminated the anoxic zone in the bottom of the aeration basins that had provided denitrification and nutrient removal. These modifications resulted in a reduction in ammonia concentrations but increased their overall total nitrogen and total phosphorus effluent concentrations (*Table 6-21*). The increases in the effluent concentrations resulted in an increase in the instream nitrogen and phosphorus concentrations (see data discussion below). Their annual TN and TP loads are, however, below their respective loading limits (*Table 6-20*). Their NPDES permit is in the process

of being renewed. There is a proposed decrease to their ammonia limits from 2 and 4 mg/L down to 1.5 and 2.8 mg/L monthly summer and winter concentrations, respectively, at 7.5 MGD. On July 16, 2020, the City requested a permit modification to add a treatment flow tier of 5.5 MGD.

*Table 6-20: Reidsville WWTP Annual Total Nitrogen and Total Phosphorus Jordan Lake Allocation and their Load to the Haw River between 2015 and 2022.*

Reidsville WWTP NC0024881	Allocation lbs/yr	2015 lbs/yr	2016 lbs/yr	2017 lbs/yr	2018 lbs/yr	2019 lbs/yr	2020 lbs/yr	2021 lbs/yr	2022 lbs/yr
<b>Total Nitrogen</b>	120,674	26,670	63,256	109,198	74,792	60,997	90,993	79,419	85,598
<b>Total Phosphorus</b>	15,169	2,061	4,496	6,951	10,438	5,139	7,427	5,199	9,084

Jordan Lake nutrient strategy (15A NCAC 02B .0270)

*Table 6-21: Reidsville Wastewater Treatment Facility (NC0024881) Monthly Mean Effluent Nutrient Concentrations for 4.5 Years Before and After Their Treatment Plant Upgrade in 2016*

Effluent Nutrient	Before Upgrade Jan. 1, 2012 - May 31, 2016			After Upgrade June 1, 2016 – Dec. 31, 2020			Monthly Mean Concentration Increase or Decrease
	Mean	Minimum	Maximum	Mean	Minimum	Maximum	
<b>Total Nitrogen (TN)</b>	3.61	1.97	8.09	<b>11.47</b>	5.03	19.03	<b>Increase</b>
<b>Ammonia (NH3)</b>	<b>0.55</b>	0.13	3.04	0.06	< 0.1	0.33	Decrease
<b>Nitrate + Nitrite (NOx)</b>	1.57	0.52	5.33	<b>9.67</b>	3.57	17.58	<b>Increase</b>
<b>Total Kjeldahl Nitrogen (TKN)</b>	<b>2.06</b>	1.28	4.36	1.81	0.31	3.50	Decrease
<b>Total Phosphorous (TP)</b>	0.23	0.09	0.60	<b>1.01</b>	0.07	4.80	<b>Increase</b>

From (DWR BIMS eDMR Calculated Monthly Mean 9/22/2021).

Several stations were assessed in the upper headwater Haw River watershed as part of the 1,4-dioxane special study in the Cape Fear River basin. Investigations identified two specific SIUs as the source of 1,4-dioxane released into the upper Haw River via the City of Reidsville’s WWTP. One of those SIUs, Unifi Inc., was able to significantly reduce 1,4-dioxane contributions with product substitution and the other identified SIU, DyStar LP, removed specific products from their manufacturing line to reduce 1,4-dioxane in its waste stream. Elevated 1,4-dioxane concentrations were observed at station B4 (Troxler Mill Rd), approximately 6.5 miles downstream of the WWTP discharge point. This section of the Haw River is classified as a Water Supply-IV (WS-IV). Between 2018 and 2019, 22 samples were collected at station B4. Of these, 17 samples (77%) had concentrations of 1,4-dioxane above the PQL with a mean concentration of 5.9 µg/L and a maximum concentration of 28 µg/L (See Chapter 13 for data figures and summary tables). In contrast, instream concentrations decreased significantly between 2020 and 2024, with only two out

of 48 total samples (4%) at or above the PQL. The highest concentration recorded at station B4 during this time period was 1.2 µg/L in September 2021.

For this assessment (2002-2020), there are seven ambient water quality monitoring stations (four AMS, two UCFRBA coalition, one co-located), eight benthic macroinvertebrate stations (including both basin and special study sites) and one fish community station used to assess the water quality conditions over this time period. Ambient (*Table 6-22*) and biology stations discussed in this section were used in the 2022 IR. A complete list of all 2002 to 2020 stations is located in the Chapter 2 Appendix, Table 3.

To assess the general water quality of the Headwaters Haw River watershed (0303000202) as a whole, stations B0170000 and B0210000, the furthest downstream ambient monitoring stations, were used to represent the current conditions in this watershed. The overall instream nutrient concentrations and conductivity levels are much lower than those found in the other 10-digit HUCs in the Haw River/Jordan Lake subbasin (*Table 6-10*). The 2016-2020 mean TN and TP concentration for this HUC-10 was 0.98 and 0.06 mg/L respectively compared to 2.10 and 0.13 mg/L for the whole HUC-8 Haw River watershed and 3.35 and 0.19 mg/L for the Reedy Fork watershed respectively for comparison (*Table 6-10*). The mean turbidity was however similar with 20.8 versus 20.2 NTU for the HUC-10 and HUC-8, respectively, and the fecal coliform bacteria concentration while elevated, was much lower with a mean concentration of 429 versus 749 cfu/100mL, respectively (*Table 6-10*).

*Table 6-22: Headwater Haw River (0303000202) Ambient Monitoring Stations Collected by DWR and the Upper Cape Fear River Basin Association Monitoring Coalition.*

Station ID	Station Location	Monitoring Program*	County	Stream AU#	Stream Classification + NSW	HUC 12
B0040000	HAW RIVER AT SR2109 NR OAK RIDGE	AMS	Guilford	16-(1)A	WS-V	30300020201
B0050000	HAW RIVER AT US 29 BUS NR BENAJA	AMS/UCFRBA	Rockingham	16-(1)c1	WS-V	30300020204
B0070010	TROUBLESOME CREEK AT US 29 BUS NR REIDSVILLE	UCFRBA	Rockingham	16-6-(3)	WS-V	30300020203
B0160000	LITTLE TROUBLESOME CREEK AT SR 2600 NR REIDSVILLE	AMS	Rockingham	16-7-(1)b	WS-V	30300020205
B0170000	HAW RIVER AT SR 2620 HIGH ROCK RD. NR WILLIAMSBURG	UCFRBA	Rockingham	16-(6.5)	WS-IV	30300020207
B0190000	HAW RIVER AT NC 87 ALTAMAHAW	AMS	Alamance	16-(10.5)b	WS-V	30300020207
B0210000	HAW RIVER AT SR 1561 NR ALTAMAHAW	AMS	Alamance	16-(10.5)b	WS-V	30300020207

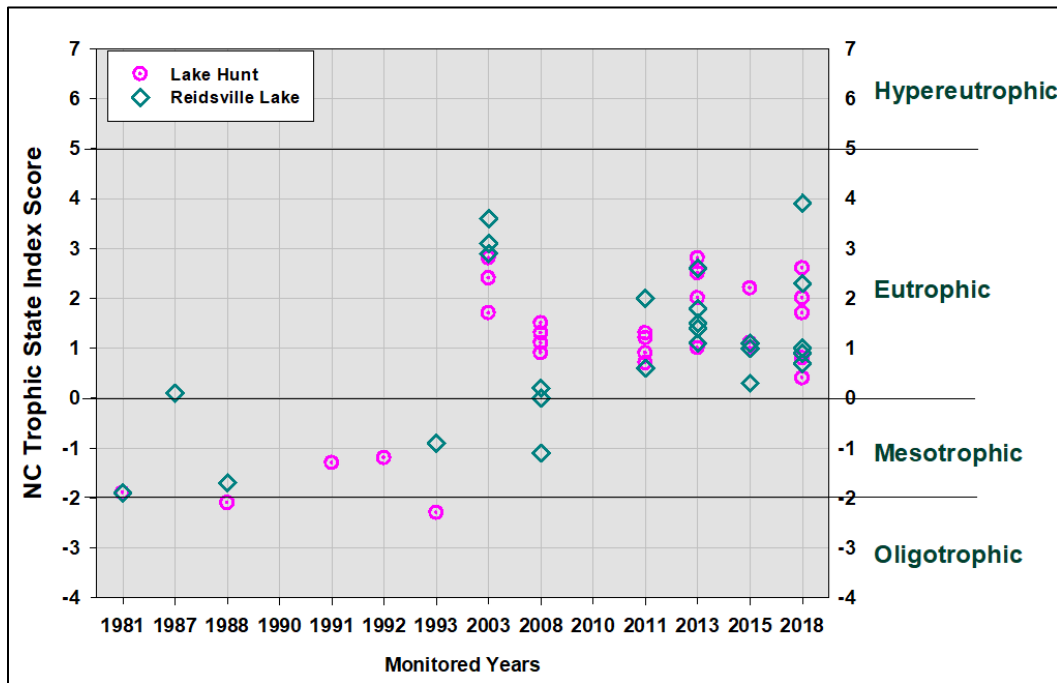
Monitoring Program\*: AMS = DWR Ambient Monitoring System; UCFRBA = Upper Cape Fear River Basin Association; RAMS=DWR Random Ambient Monitoring System. Green highlights stations no longer sampled.

There are several TMDLs in the Headwater Haw River subwatershed (*Table 6-12*) including two for fecal coliform bacteria in Little Troublesome Creek and in the Haw River. The TMDLs for the Haw River and Little Troublesome Creek indicate that there are excursions of the standards regardless of flow or season, indicating that there is a need for implementation of measures that address fecal coliform bacteria during both wet and dry seasons/conditions. A significant increasing trend over the last 10 years (2010-2019) was identified at B0210000 (at the 95% confidence level).

There is also a TMDL for turbidity in the lower 1.3-mile segment of the Haw River [AU# 16-(1)d] that calls for a 61% reduction in loading. This small segment of the Haw River is the uppermost reach of the 2005 Haw River turbidity TMDL. The 61% required reduction is based on data collected at station B1140000 in the Back Creek-Haw River subwatershed (HUC 0303000204). Turbidity was also higher at B0210000 over the last 10 years. *Implementation measures are needed throughout the headwaters of the Haw River in order to achieve the reduction required to meet the TMDLs.* A more detailed discussion of the watershed water quality conditions is available below.

The water quality conditions throughout the subwatershed (0303000202) are discussed in detail below. The 2022 impaired waters is divided into two tables: one specifically for the Headwater Haw subwatershed (*Table 6-23*) and one for the entire length of the mainstem Haw River only, which will be referred to throughout the mainstem Haw River discussions below (*Table 6-24*).

Figure 6-52: Headwater Haw River Watershed Lake Trophic Status (NCTSI).



Yearly average (1980s and 1990s) or monthly lake NCTSI average (2000 to present) are presented (data from WSS/ISB Lakes Program, January 2020).

Table 6-23: 2022 IR Water Quality Impairments by Stream Segment (AU#) for Headwater Haw River HUC 0303000202.

Stream	AU#	Classification	Description	Impairment Parameter (IR category)
Haw River	16-(1)a	C, NSW	From source to SR2109	Benthos (5)
	16-(1)c1	C, NSW	From SR 2426 to Troublesome Cr. at US29	Copper - Legacy (5)
Troublesome Creek	16-6-(03)	WS-III; NSW	From source to Rockingham County SR 2423	Benthos (5)
Little Troublesome Creek	16-7-(1)a	WS-V; NSW	From source to Reidsville WWTP	Benthos (5); Fecal Coliform (4t)
	16-7-(1)b	WS-V; NSW	From Reidsville WWTP to SR2600	Turbidity (5); Fecal Coliform (4t & 3a)
	16-7-(2)	WS-IV; NSW	From SR 2600 to Haw River	Benthos (5); Fecal Coliform (4t)

Table 6-24: 2022 (IR) Water Quality Impairments by Stream Segment (AU#) for the Entire Mainstem Haw River Throughout HUC 03030002.

Haw River AU	HUC-10 0303000 & Stream Class	~Stream Length (Miles/ Acres)	Description	Stations	2022 IR Categories & Parameter of Concern	Discharge to AU
16-(1)a	202 WS-V; NSW	7.8	From source to SR 2109	B0040000 BB006-Fair BF93-Good-Fair	5 - benthos	
16-(1)b	202 WS-V; NSW	12.5	From SR 2109 to 2426		Not on the 2022 IR list	
16-(1)c1	202 WS-V; NSW	7.3	From SR 2426 to Troublesome Cr. at US 29	B0050000	5 – Copper (Legacy)	
16-(1)c2	202 WS-V; NSW	13.9	From Troublesome Cr. at US 29 to NC 87	BB		
16-(6.5)	202 WS-IV; NSW	9.4	From a point 0.9 miles downstream of Troublesome Creek to a point 0.5 miles downstream of SR2711	B0170000 BB5-Good-Fair	3a- Turbidity 3a – Fecal CB <u>Missing</u> 3a – 1,4-Dioxane	1 Major = 7.5 MGD Reidsville WWTP discharge point 1 Minor = 23,500 gpd Pleasant Ridge MHP
16-(10)	202 WS-IV; NSW; CA	0.6	From a point 0.5 miles downstream of SR 2711 to point 0.1 miles upstream of SR 2712	BB		
16-(10.5)a	202 WS-V; NSW	4.2	From a point 0.1 miles upstream of SR 2712 to NC 87	B1 Special Study	3a – 1,4-Dioxane	1 Minor = 12,000 gpd Alamance-Burlington School
16-(10.5)b	202 WS-V; NSW	1.3	From NC 87 to Reedy Fork	B0210000	3a- Turbidity 3a – 1,4-Dioxane	

Haw River AU	HUC-10 0303000 & Stream Class	~Stream Length (Miles/ Acres)	Description	Stations	2022 IR Categories & Parameter of Concern	Discharge to AU
				BB163-Good- Fair		
16-(10.5)c	204 WS-IV; NSW	10.1	From Reedy Fork to Service Cr.	B1020000 BB002- Not Rated	3a- Turbidity 3a – Fecal CB	2 minors = 26,500 gpd Western Alamance MS & HS
16-(10.5)d	204 WS-V; NSW	2.1	From Service Cr. to NC 49. (Haw R. at Haw River)	B1140000	3i – Turbidity 3t – TSS 4t – Fecal CB	1 Major = 12 MGD Burlington – Eastside WWTP
16-(10.5)e* HUC 10 0303000204 portion only	204 WS-V; NSW	5.5	From NC 49 to Big Alamance Cr.	B1200000 B1440000 BB022 – Good	3a- Turbidity 3a – Fecal CB	1 Major = 3.5 MGD Graham WWTP
16-(10.5)e* HUC 10 0303000205 portion only	205 WS-V; NSW	13.5	From Big Alamance Cr. to a point 0.4 miles downstream of Cane Creek (Southside)	B1980000 B2000000 BB220 – Good	3a- Turbidity 3a – Fecal CB	2 minors = 22,500 gpm Saxapahaw WWTP & Jordan ES (note: limited nutrient data available at B1980000)
16-(28.5) HUC 10 0303000205 portion only	205 WS-IV; NSW	8.6	From a point 0.4 miles downstream of Cane Creek (Southside) to HUC 205/207 boundary	BB529 – Good		None
16-(28.5) HUC 10 0303000207 portion only	207 WS-IV; NSW	3.4	From HUC 205/207 boundary to a point 0.5 miles upstream of the Town of Pittsboro water supply intake.	BB529 – Good		None
16-(28.75)	207 WS-IV; CA; NSW	0.5	From a point 0.5 miles upstream of the Town of Pittsboro water supply intake to the Town of Pittsboro water supply intake	None	Not on the 2022 IR list	
16-(28.875)	207 WS-IV, NSW	0.5	From the Town of Pittsboro water supply intake to a point 0.4 miles downstream of Brooks Branch	B2100000	3a - 1,4-Dioxane	1 minor – Pittsboro WTP
16-(36.3)	207 WS-IV; CA; NSW	0.5	From a point 0.4 miles downstream of Brooks Branch to Pittsboro water supply intake	None	No Data	2 minors – 50,000 gpd Chatham County WWTP and Bynum WWTP
16-(36.7)	207 WS-IV; NSW	3.8	From Pittsboro water supply intake to a point 0.5 miles downstream of US Hwy 64	BB443-Good		Future – Pittsboro WWTP Outfall 002
16-(37.3)	207 WS-IV; CA; NSW	53.23 Acres	From a point 0.5 miles downstream of US Hwy 64 to ~ 1.0 miles below US Hwy 64		Not on the 2022 IR list	
16-(37.5)a1	207 WS-IV, CA, B, NSW	694.5 Acres	From ~ 1.0 miles below US Hwy 64 to Stinking Creek Arm	CPF055C	4i – pH (>9) 4i – Chl a 4i – Turbidity 4t – Total Nitrogen 4t – Total Phos 4t - TSS	No discharge directly to the lake but to Robeson Creek (Pittsboro WWTP outfall 001) which drains to this segment of the lake.
16-(37.5)a2	207	651.5 Acres	From downstream of Stinking Creek Arm to dam at Jordan Lake	CPF055D	4i – pH (>9) 4i – Chl a	

Haw River AU	HUC-10 0303000 & Stream Class	~Stream Length (Miles/ Acres)	Description	Stations	2022 IR Categories & Parameter of Concern	Discharge to AU
	WS-IV, CA, B, NSW			CFR055E	4i – Turbidity 4t – Total Nitrogen 4t – Total Phos 4t - TSS	
16-(42)	207 WS-IV	4.3	From dam at Jordan Lake to Cape Fear River (junction with Deep River)	B4050000 B4080000		2 major -Moncure Holdings West Inc. (0.244MGD); Arclin USA Inc. – (0.1 MGD) 1 minor – Southern Veneer Specialty Products (8,000 gpd);

### 6.6.2.1 Troublesome Creek

Troublesome Creek is mainly a rural, forested (45%) and agricultural (32%; mainly row crop and pastures) watershed that drains to the Haw River approximately 2.5 miles upstream of Little Troublesome Creek’s confluence with the Haw River [2019 Land Use at station B0070010 (2.3% impervious cover; see the Chapter 2 Appendix *Land Use Land Cover for AMS and Coalition Station Watersheds* table)].

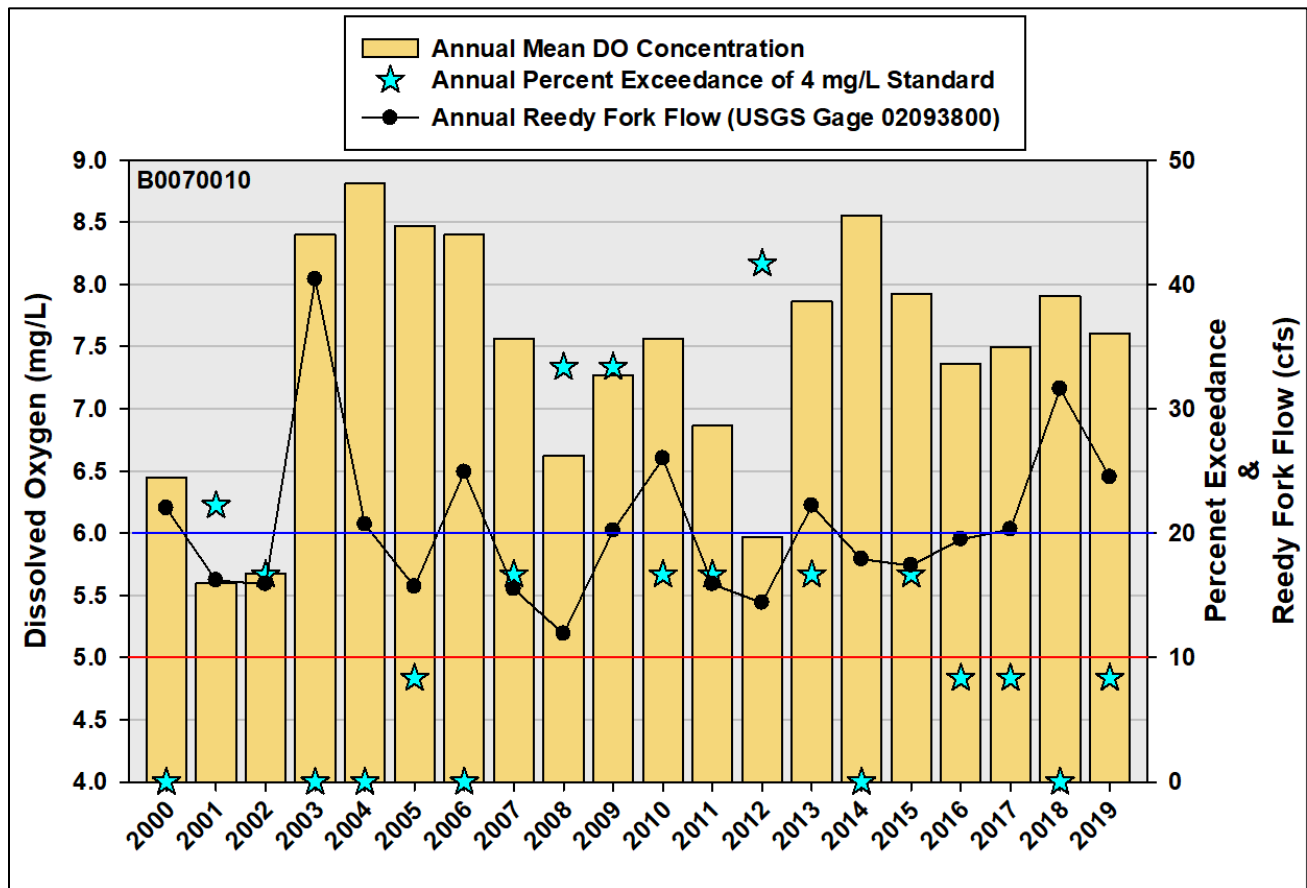
Troublesome Creek [AU# 16-6-(0.3); WS-III; NSW] from the source to Rockingham County SR 2423 was assessed using biological data at benthos community station BB396, which is located 5.5 miles southwest of downtown Reidsville in southern Rockingham County and 1.2 stream-miles above Lake Reidsville (*Figure 6-12*). This station has maintained a good-fair bioclassification since 1993; however, in 2013 the stream received a fair bioclassification. The fair classification was a reflection of the decline in richness of pollution intolerant species represented by the insect orders *Ephemeroptera*, *Plecoptera*, and *Trichoptera* (EPT) from 17 in 2008 to 12 in 2013. The EPTBI (5.38) also increased, indicating a more tolerant EPT fauna compared to previous basinwide sampling events. As a result of this decline in aquatic life for the biological community, Troublesome Creek was placed on the impaired waters list in 2016. This stream remains on the 2022 impaired waters list (*Table 6-23*). This site should be resampled as time and resources allow.

BB396	
Year	Bioclassification
2002	Good-Fair
2008	Good-Fair
2013	Fair

Troublesome Creek (Lake Reidsville) [AU# 16-6-(0.7); WS-III, CA, NSW] from Rockingham County SR 2423 to the dam at Lake Reidsville (City of Reidsville water supply intake) was sampled five times between May and early September 2018. The water supply was not rated due to eutrophic conditions resulting in elevated biological productivity throughout much of the summer growing season (*Figure 6-52*). The upstream station had the highest chlorophyll *a* concentration which ranged from 15 to 28 µg/L. There were low Secchi depth (0.2 – 0.7 m) and high turbidity (23-45 NTU) readings in August 2018, indicating that this watershed was likely impacted by runoff during a heavy rain event the week prior to sampling (NC DEQ, 2018). *It is recommended that the county Soil and Water Conservation Districts work with willing landowners to install BMPs to reduce nutrients, sediment and fecal coliform bacteria draining to this water supply reservoir.*

Troublesome Creek [AU# 16-6-(3); WS-V; NSW] from the dam at Reidsville Lake to Haw River is regularly assessed using data collected at station B0070010 (~ 0.75 miles downstream of dam and ~ 1 mile upstream of the confluence with the Haw River). The lower segment below the dam has been listed as impaired between 2010 and 2018 due to low dissolved oxygen issues. Half of the years between 2000-2019 had excursions below the 4 mg/L DO standard more than 10% of the time, with 80% of those occurring during years in which the mean annual flow was below the 20-year mean flow of 20.66 cfs (at a nearby small stream flow gage). This is likely influenced by the presence of the dam and water released from the bottom portion of the lake. There is a 3.5 cfs minimum release, so the bottom water releases during low flow periods could result in extended periods of low dissolved oxygen downstream at B0070010 (DEMLR Dam Safety Inventory, July 2021 data; *Table 6-25* and *Figure 6-53*).

*Figure 6-53: Troublesome Creek Station B0070010 Annual Mean Dissolved Oxygen Concentrations and Upper Reedy Fork USGS Flow Gage #02093800 Stream Flow.*



Dissolved Oxygen Concentrations shown with Percent Exceedances of the 4 mg/L Standard. USGS Flow Gage #02093800 Stream Flow is the Closest Small Stream Gage Data Available. Red Line Denotes the 10 Percent Exceedance Line and the Blue Line Denotes the 20-Year Flow Mean (2000-2019).

Table 6-25: Troublesome Creek Station B0070010 Annual Dissolved Oxygen Data Summary with Small Stream Flow Data for Upper Reedy Fork USGS Flow Gage #02093800.

Year	Mean (mg/L)	Median (mg/L)	Minimum (mg/L)	Maximum (mg/L)	Percent Exceedance Rate	Number of Records	USGS Annual Flow Gage # 02093800 Reedy Fork nr Oak Ridge <sup>^</sup>
2000	6.4	6.3	4.0	9.1	0.00%	9	22
2001	5.6	4.9	3.4	10.3	22.20%	18	16.2
2002	5.7	5.5	2.5	11.0	16.70%	12	15.9
2003	8.4	8.2	6.0	13.0	0.00%	12	<b>40.4</b>
2004	8.8	9.6	5.5	11.6	0.00%	12	20.7
2005	8.5	8.4	3.8	12.0	8.30%	12	15.7
2006	8.4	8.0	5.6	12.0	0.00%	12	24.9
2007	7.6	7.9	3.1	11.0	16.70%	12	15.5
2008	6.6	6.9	2.5	12.0	33.30%	12	<b>11.9</b>
2009	7.3	8.5	2.5	12.5	33.30%	12	20.2
2010	7.6	7.4	2.9	11.1	16.70%	12	26
2011	6.9	7.4	2.5	10.9	16.70%	12	15.9
2012	6.0	5.2	2.2	11.9	41.70%	12	14.4
2013	7.9	8.1	3.1	11.5	16.70%	12	22.2
2014	8.6	8.5	4.3	11.9	0.00%	12	17.9
2015	7.9	7.6	3.4	12.4	16.70%	12	17.4
2016	7.4	8.0	3.2	10.6	8.30%	12	19.5
2017	7.5	7.6	3.2	10.8	8.30%	12	20.3
2018	7.9	7.8	4.0	11.8	0.00%	12	31.6
2019	7.6	7.5	3.1	11.3	8.30%	12	24.5

Green highlighted rows represent years with more than 10% excursion of the 4 mg/L DO standard. Bolded Flow Values are for the Highest and Lowest Annual Flows Over this Time Period of 2000-2019.

<sup>^</sup>Closest small stream USGS gage used as a surrogate flow for Troublesome Creek.

Small stream flow represented by USGS Gage 02093800 - Reedy Fork 2000-2019 mean flow = 20.66 cfs; Min 11.9 cfs (2008); Max 40.4 cfs (2003).

DWR conducted screening level seasonal Mann-Kendall trend tests at 95% confidence for monitoring data collected from 2000 to 2019. There is an increasing trend in turbidity concentration in the lower segment of the watershed identified between 2000-2019 (Table 6-26). This section is not impaired for turbidity; however, efforts should be made to control runoff to eliminate excess volume and pollutants from entering surface waters. The 2022 IR period mean concentration was 14.7 NTU with a maximum of 65.1 NTU and an excursion rate of 6% (Table 6-26).

Overall, nutrients are relatively low in this lower section of Troublesome Creek with the exception of a 2016 TKN reading of 12.7 mg/L that increased the overall watershed TN and TKN mean (Table 6-26 and

Figure 6-54). The ammonia concentrations are on the higher end with a five-year 2022 IR period mean of 0.08 mg/L, median of 0.06 mg/L and a maximum of 0.62 mg/L (Table 6-26 and Figure 6-54). The ammonia mean of 0.08 mg/L is higher than all of the HUC-10 subwatershed means except for the 0.10 mg/L mean for Reedy Fork (Table 6-10).

Table 6-26: Troublesome and Little Troublesome Creek Watershed (0303000202) Five-Year Instream Mean Concentration at Ambient Stations (2016-2020) with Seasonal/Nonseasonal Mann-Kendall Trends (Calculated at 95% Confidence).

Watershed Information	Station	TN# (mg/L)	NOx (mg/L)	TKN (mg/L)	NH3 (mg/L)	TP (mg/L)	Fecal C. (cfu/100 mL)	Turbidity (NTU)	Conductivity (µS/cm)	Station Trend* 2000-2019 & 2010-2019 Decreasing (↓) or Increasing (↑) Seasonal (S) or Non- Seasonal (NS)	HUC 12 03030002 & Stream Class + NSW
Troublesome Creek Below Lake Reidsville	B0070010	1.07	0.18	0.89	0.08	0.03	173	14.7	70	NOx - ↑ S 10-19; TKN - ↑ NS 10-19; TP - ↓ NS 10-19; Fecal C - ↓ S 00-19; Turbidity & TSS - ↑ S 00-19	0203 WS-V
Little Troublesome Creek Downstream of Reidsville, NC	B0160000	0.96	0.60	0.36	0.03	0.07	604	26.6	126	NH3 - ↓ S 00-19; NOx - ↑ S 00-19 & S 10-19; TP - ↓ S 00-19; Turbidity - ↓ NS 00-19; Fecal C - ↑ S 10-19	0205 WS-IV

# TN is calculated as NOx + TKN. Both values were required to develop a TN value.

\* DWR conducted a seasonal or nonseasonal Mann-Kendall trend test at most AMS stations that had sufficient data available; reporting only significant increasing or decreasing trends

Station B0070010 is about 0.75 miles downstream of the dam and Troublesome Creek has a wide riparian buffer from the dam to the confluence with the Haw River. The possible sources of elevated ammonia could be the water released from the bottom of Lake Reidsville and/or discharge from the Reidsville drinking water treatment plant (NC0046345) which is the only permitted facility upstream of the monitoring point. According to the [2021 permit fact sheet](#), the water treatment plant discharges a maximum monthly average wastewater discharge of approximately 0.385 MGD (based on February 2018-January 2021 review). Reviewing the available quarterly nitrogen effluent data since 2010, Reidsville WTP had several high TN and ammonia concentrations, especially between 2015 and 2020 which could explain the higher ammonia and possibly the high TKN reading recorded during that time frame (Figure 6-55). The WTP has also failed several of their WET toxicity tests in recent years. They are required to perform quarterly chronic toxicity test using *Ceriodaphnia dubia* (water flea) at an effluent concentration of 90%. DWR is working with the discharger to determine why they are failing their WET tests.

The screening level seasonal Mann-Kendall trend tests (at 95% confidence) found an increasing seasonal NOx trend and a non-seasonal TKN trend between 2010 and 2019 as well as a decreasing non-seasonal trend in TP (Table 6-26).

Figure 6-54: Troublesome Creek Nutrient Constituent Concentration at Station B0070010 between 2002 and 2019.

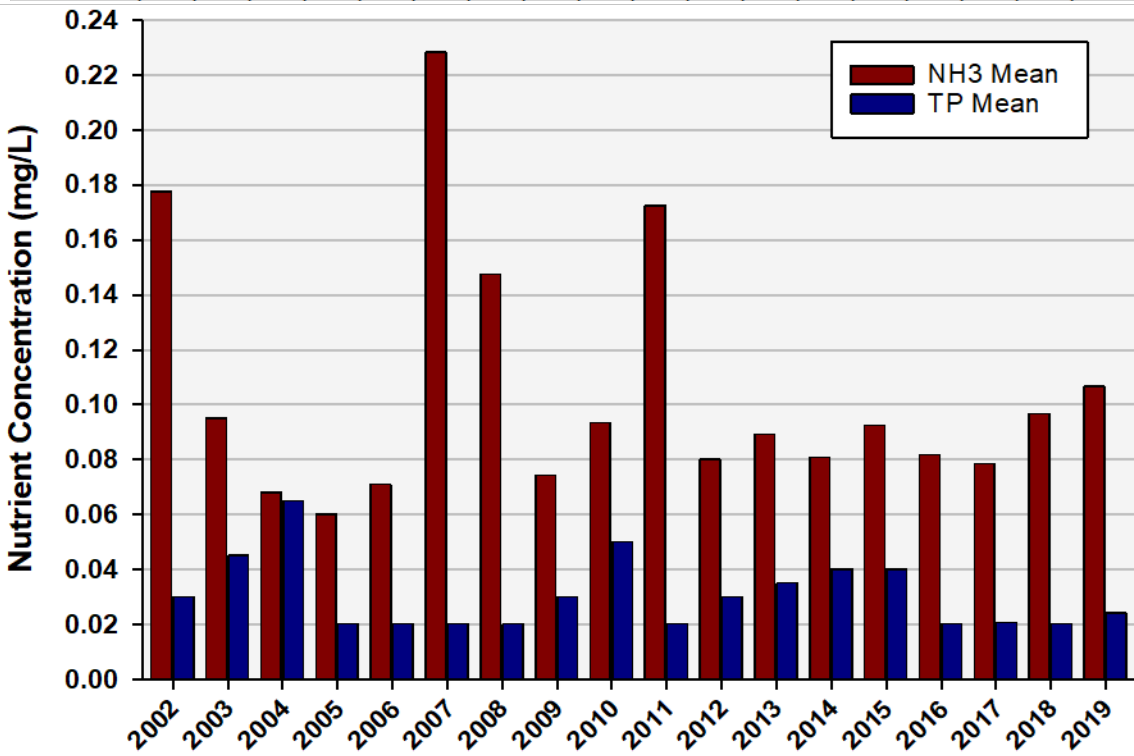
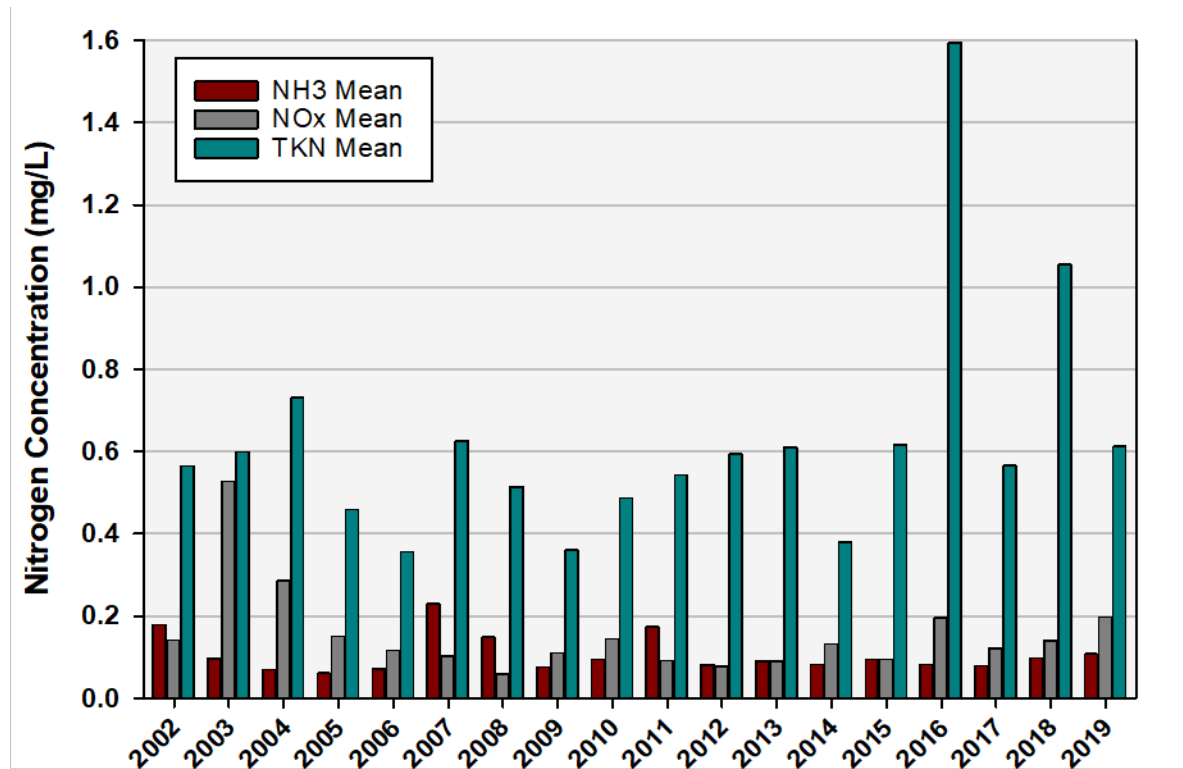
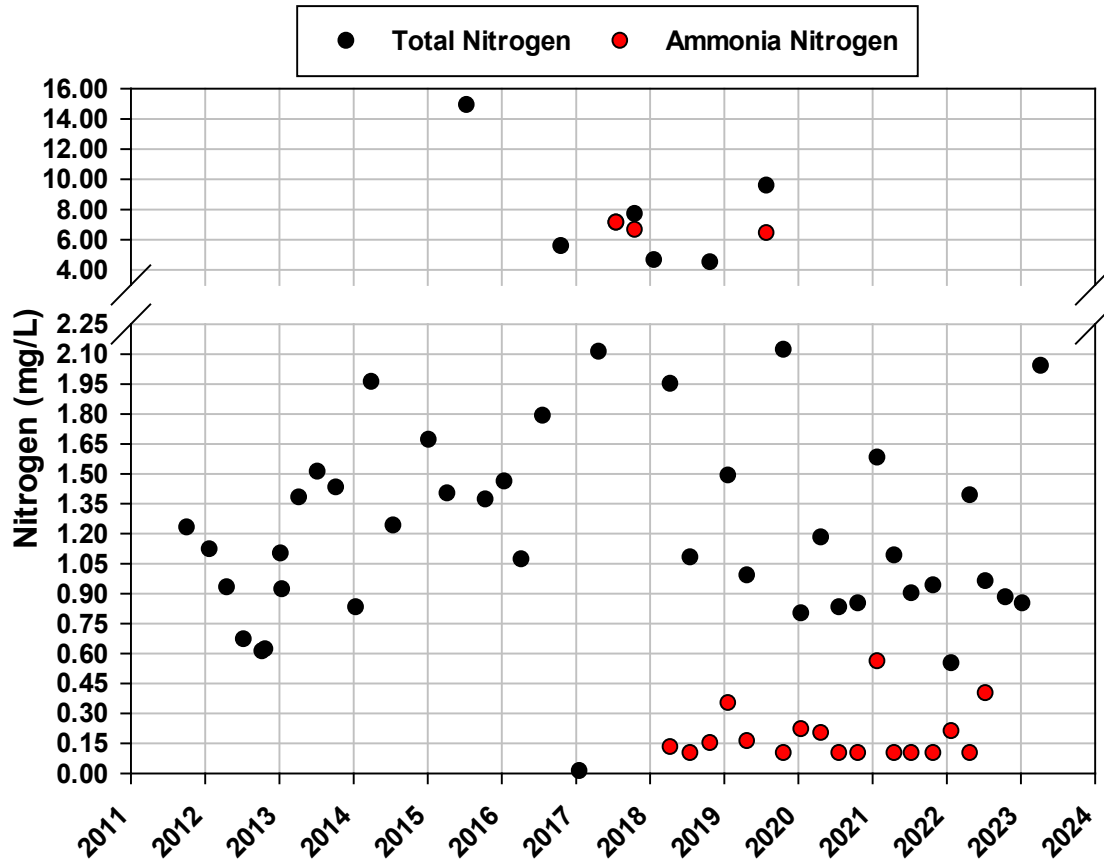


Figure 6-55: Reidsville Water Treatment Plant (NC0046345) Total Nitrogen and Ammonia Effluent Concentrations from January 2010 to April 2023 (data pull June 24, 2023). (Note the scale break on the Y-axis).



### 6.6.2.2 Little Troublesome Creek

Little Troublesome Creek [AU# 16-7-(1)a and 16-7-(1)b; WS-V; NSW] from the source to Rockingham County SR 2600 (Mizpah Church Rd.) was assessed previously using biological data and remains impaired for aquatic life (2022 IR; [Table 6-23](#)). The headwater section of Little Troublesome Creek encompasses the Town of Reidsville and is mainly an urban watershed as described above (~77% developed with 22% impervious land area). Impacts to the upper Little Troublesome Creek are the result of nonpoint source urban runoff which needs to be addressed before additional monitoring is warranted. The town moved their WWTP discharge to the mainstem Haw River to address concerns with impacts to Little Troublesome Creek.

The lower portion of Little Troublesome Creek [AU# 16-7-(2); WS-IV; NSW] from SR 2600 to the Haw River is assessed using both biological community and instream water quality standards. The fish and benthic macroinvertebrate community assessments have improved since the removal of the Reidsville WWTP effluent in November 1998. The fish, bug and ambient water quality stations are co-located at SR 2600

(Mizpah Church Rd.) approximately 3 miles downstream from the old wastewater discharge point (*Figure 6-12* and *Figure 6-16*).

Biological monitoring station BB400 on Little Troublesome Creek is located in southeastern Rockingham County and flows north northwest through areas of Reidsville. This benthic sampling station received a Fair bioclassification in 2018 due to a significant decline in EPT richness from 20 in 2008 to 11 in 2018. An improvement in EPT richness was reported in 2008 and it was noted that the Reidsville WWTP was moved from approximately three miles upstream of this sampling station to a discharge point on the Haw River in November 1998. Despite the decline from a Good-Fair to Fair benthic bioclassification from 2008 to 2018, benthic metrics do suggest improved water quality conditions beginning after the removal of the Reidsville WWTP. High amounts of precipitation prior to the 2018 benthic sample collection could have led to increased scour, sedimentation and nonpoint source pollution runoff decreasing EPT richness. Future benthic samples are recommended to assess water quality improvements.

BB400	
Year	Bioclassification
2003	Fair
2008	Good-Fair
2018	Fair
BF63	
2009	Good-Fair
2013	Good-Fair

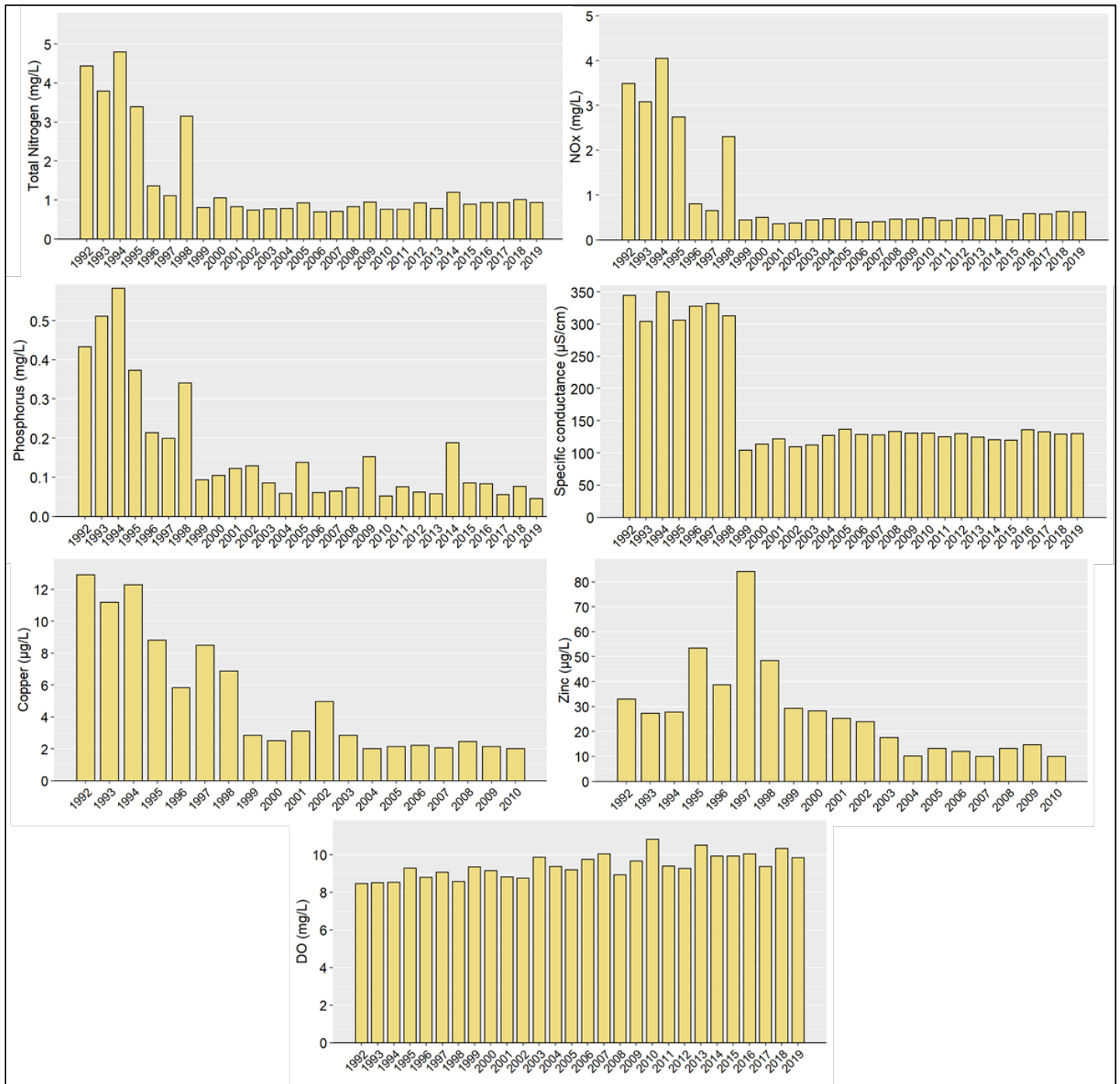
In 2013 at fish community site BF63, a slight decline in NCIBI score was due to fewer fish and species of sunfish collected. The number of fish declined by 66% between 2009 and 2013 (316 vs. 106) and the greatest percentage of nonindigenous species (27%) and nonindigenous fish (32%) in the basin were collected at this site. Twenty-one species in total are known from the site, including eight species of cyprinids and three nonindigenous species; no suckers, species of *Notropis*, or intolerant species have ever been collected at this site. The dominant species are bluegill (23%) and bluehead chub (22%). Improvements in the fish community were documented after the discharge was relocated in 1998, but improvements have plateaued. Continued basinwide assessment should be done at both the fish and benthos sites in 2023 to document any improvements in the biological communities resulting from a [stream and wetland restoration project](#) that was completed by a full delivery provider for the Division of Mitigation Services in 2012.



Long-term instream water quality chemical and physical data also show improvement following the 1998 removal of the town’s effluent discharge as seen by a drastic drop in nitrogen, phosphorus, specific conductivity, total copper, total zinc and the gradual increase in dissolve oxygen concentrations at station B0160000 (*Figure 6-56*). The drop in total nitrogen was mainly due to the decrease in inorganic-nitrate nitrogen, however organic nitrogen and ammonia all declined in response as well.

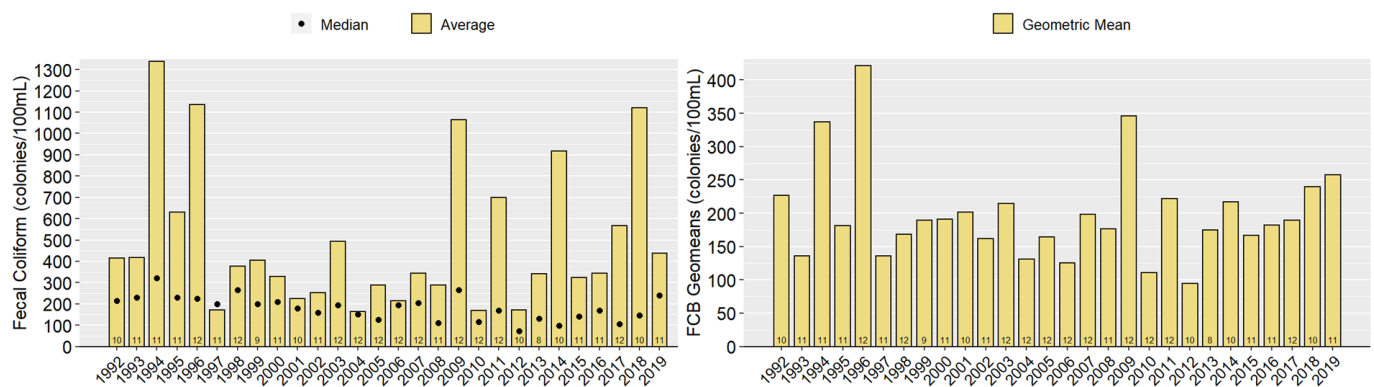
However, a screening level Mann-Kendall trend analysis (calculated at 95% confidence) found a significant increasing seasonal trend in nitrate and specific conductance for data collected from 2000-2019, and for fecal coliform bacteria and nitrate for data collected from 2010-2019 (*Table 6-26*). The resulting slow but steady increases in these parameters is likely due to stormwater sources throughout this watershed. TP concentration trend however decreased between 2000-2019 (seasonal) (*Table 6-26*).

Figure 6-56: Little Troublesome Creek Water Quality Improvement Post Removal of the Town of Reidsville's WWTP Effluent in November 1998 at AMS Station B0160000 (located at Mizpah Church Rd.).



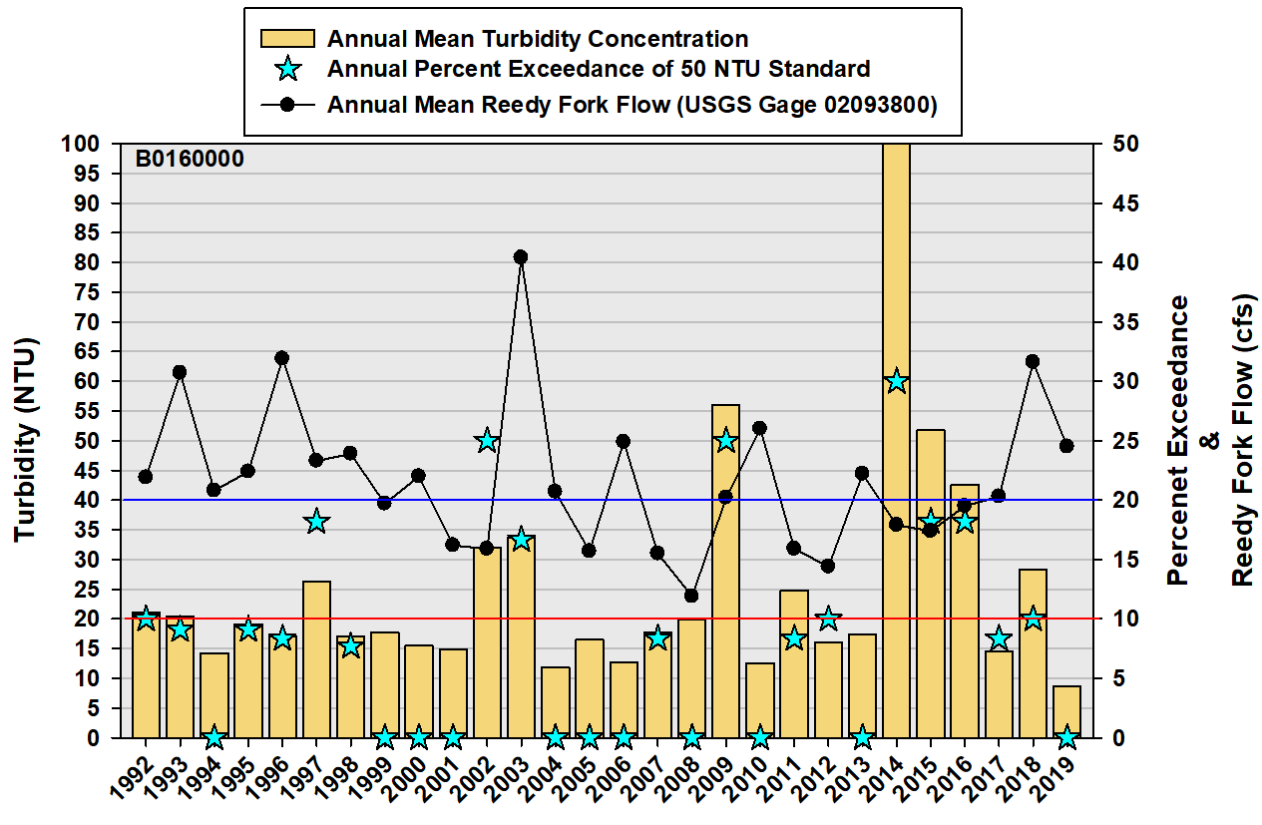
The entire length of Little Troublesome Creek remains impaired for aquatic life due to the watershed impacts to the benthic macroinvertebrate community and for fecal coliform bacteria. There is a 2002 EPA approved TMDL which identified a 40 percent reduction in loading from the watershed was needed to achieve the instream water quality criterion (2002, DENR [Little Troublesome Creek Fecal Coliform Bacteria TMDL](#)). The major sources were identified as runoff from urban areas, possibly including leaking sewer lines, miscellaneous instream sources (particularly illicit discharges and cattle in the stream) and septic systems. Livestock grazing on agricultural lands, cattle in the creek and wildlife were also identified as contributing sources. Based on the modeling results, the most important implementation efforts should focus on reducing loading from the urban areas in and around the City of Reidsville, but all reasonable source reductions are needed (2002, DENR). Elevated bacteria levels occurred throughout the year, during both dry and wet weather conditions. The current instream data (*Figure 6-57*) and 10-year trends analysis indicate that there is a continued increase in bacteria levels at station B0160000 (2010-2019 trend assessment at 95% confidence) (*Table 6-26*). The 2022 IR mean fecal coliform bacteria concentration was 604 cfu/100 mL (*Table 6-26*).

*Figure 6-57: Little Troublesome Creek Annual Mean Fecal Coliform Bacteria Concentrations 1992-2019 at Station B0160000.*



The lower half of Little Troublesome Creek was added to the 2020 impaired waters list due to elevated instream turbidity levels between 2014 and 2018, where the turbidity concentration was above the 50 NTU water quality standard 16.7% of the time (2014-2018 is the 2020 IR data window). There is no stream flow gage in Little Troublesome Creek, so the upper Reedy Fork gage was used as a surrogate for local small stream annual flow and did not show a specific relationship with turbidity concentrations (*Figure 6-58*). Elevated turbidity concentrations occurred in 2014, 2015 and 2016 specifically while the surrogate flow was near the normal 20-year annual average range (~20 cfs, blue line on graph; *Figure 6-58*). Additional data analysis would be needed to further flesh out the possible links to local precipitation and runoff events or to specific activities (construction projects) that occurred in the watershed. The annual mean turbidity concentrations dropped substantially after 2016 (*Figure 6-58*). This impairment will likely change over time based on activities in the watershed. See the most current NC approved [Integrated Report](#) for changes in impairments throughout the watershed.

Figure 6-58: Little Troublesome Creek Station B0160000 Annual Mean Turbidity Concentrations with Percent Exceedances and Upper Reedy Fork USGS Flow Gage #02093800.



The Upper Reedy Fork USGS Flow Gage #02093800 stream flow is the closest small stream gage data available. The red line denotes the 10 percent exceedance line and the blue line denotes the 20-year flow mean (2000-2019).

### 6.6.2.3 Haw River Mainstem

The mainstem Haw River flows through four of the six HUC-10 watersheds that make up the Haw River Subbasin (03030002). The water quality assessment of the mainstem Haw River is broken up and reported in each of the corresponding HUC-10 sections [Headwater Haw River (section 6.6.2), Back Creek (section 6.6.4), Cane Creek (section 6.6.5), and Robeson Creek (section 6.6.7)]. A 2022 IR Impairments (Table 6-24) and associated five-year mean concentrations and trend analysis (Table 6-27) is included for the full length of the Haw River mainstem for easy reference and comparison purposes. The Headwater Haw River subwatershed has the lowest overall five-year mean nutrient concentration of all the HUC-10 subwatersheds in the Haw River subbasin (Table 6-10), which is reflective of a headwater system with a high percentage of forest lands and few permitted dischargers. Reidsville WWTP is the only major discharger in the Headwater Haw River watershed.

The Haw River headwaters begin northeast of Kernersville and flows across northern Guilford and southern Rockingham counties. The Haw River upstream of the confluence with Troublesome Creek is an 80-square-mile watershed and is roughly 48% forested (a 3.4% drop since 2001) and is 16% developed (a

5% increase). (2019 NLCD at station B0050000. See the Chapter 2 Appendix – *Land Use Land Cover for AMS and Coalition Station Watersheds*).

*Table 6-27: Entire Mainstem Haw River Five-Year Instream Mean Concentration at Ambient Stations (2016-2020) with Seasonal/Nonseasonal Mann-Kendall Trends (Calculated at 95% Confidence).*

Station	TN# (mg/L)	NOx (mg/L)	TKN (mg/L)	NH3 (mg/L)	TP (mg/L)	Fecal C. (cfu/100 mL)	Turbidity (NTU)	Conductivity (µS/cm)	Station Trend* Information 2000-2019 & 2010-2019 Decreasing (↓) or Increasing (↑) Seasonal (S) or Non- Seasonal (NS)	Watershed Information	HUC 10 0303000_ & Stream Class
B0040000	0.55	0.15	0.39	0.04	0.04	227	16	86	NOx - ↑ S 00-19 & S 10-19; TKN - ↑ S 00-19; NH3 - ↑ S 00-19; Turbidity - ↓ S 10-19	Headwater Haw River	202 WS-V; NSW
B0050000	0.76	0.15	0.61	0.03	0.04	374	17	98	NH3 - ↓ S 00-19; TKN - ↑ S 00-19 & TKN - ↑ NS 10-19; TP - ↓ NS 10-19 Turbidity - ↑ S 00-19; Cond - ↑ S 00-19 & S 10-19; Fecal C. - ↓ S 10-19	Headwater Haw River	202 WS-V; NSW
B0170000	1.28	0.66	0.68	0.02	0.09	745	26	143	NH3 - ↓ S 10-19; NOx - ↑ S 10-19; Turbidity - ↑ S 00-19	Downstream of Major WWTP	202 WS-IV; NSW
B0210000	1.20	0.68	0.51	0.03	0.10	447	23	130	NOx - ↑ NS 00-19 & 10-19; NH3 - ↓ S 10-19; Fecal C - ↑ NS 00-19 & 10-19	Upstream of Reedy Fork	202 WS-V; NSW
B1020000	2.91	1.92	0.98	0.05	0.23	1148	25	249	TKN - ↑ NS 10-19	Below confluence with Reedy Fork	204 WS-V; NSW
B1140000	2.83	1.95	0.88	0.04	0.20	771	25	250	TP - ↓ S 00-19; TKN - ↑ NS 00-19; NH3 - ↓ NS 10-19 Fecal C - ↑ NS 10-19	Co-located with USGS gage; Downstream of Major WWTP	204 WS-V; NSW
B1200000	2.82	1.88	0.93	0.04	0.16	1229	27	239	TP - ↓ S 00-19; NH3 - ↓ NS 10-19	Downstream of Major WWTP	204 WS-V; NSW
B1440000	2.67	1.67	1.00	0.04	0.16	1536	27	242	TP - ↓ S 00-19; TKN - ↑ NS 10-19	Downstream of Major WWTP	204 WS-V; NSW
B1980000	NA	NA	NA	NA	NA	761	23	239	Turbidity - ↓ NS 00-19; Cond - ↓ S 10-19	Downstream of dam	205 WS-V; NSW
B2000000	2.12	1.23	0.89	0.04	0.11	851	21	218	TP - ↓ S 00-19; NH3 - ↓ S 00-19 & S 10-19; TKN - ↑ S 00-19 & NS 10-19	Downstream of Minor WWTP	205 WS-V; NSW
B2100000	1.86	1.09	0.79	0.03	0.12	515	21	200	TP - ↓ S 00-19; NH3 - ↓ S 00-19 & S 10-19; TKN - ↑ S 00-19 & S 10-19;	Co-located with USGS gage;	207

Station	TN# (mg/L)	NOx (mg/L)	TKN (mg/L)	NH3 (mg/L)	TP (mg/L)	Fecal C. (cfu/100 mL)	Turbidity (NTU)	Conductivity (µS/cm)	Station Trend* Information 2000-2019 & 2010-2019 Decreasing (↓) or Increasing (↑) Seasonal (S) or Non- Seasonal (NS)	Watershed Information	HUC 10 0303000_ & Stream Class
									Fecal C. - ↑ NS 00-19	Downstream of Bynum dam	WS-IV; NSW
B4050000	1.17	0.34	0.81	0.18	0.09	244	15	159		Downstream of Jordan Lake	207 WS-IV
B4080000	1.33	0.42	0.91	0.10	0.06	102	13	153	TP - ↓ NS 00-19; TKN - ↑ NS 10-19; Turbidity - ↑ S 10-19; Cond - ↓ S 00-19 & S 10-19	Downstream of Jordan Lake	207 WS-IV
Robeson Creek B2450000	1.37	0.58	0.78	0.05	0.07	185	16	166	TP - ↓ S 00-19 (also 1990-2019); NH3 - ↓ NS 00-19	Robeson Creek arm of Jordan Lake	207 WS-IV; B; NSW; CA

# TN is calculated as NOx + TKN. Both values were required to develop a TN value.

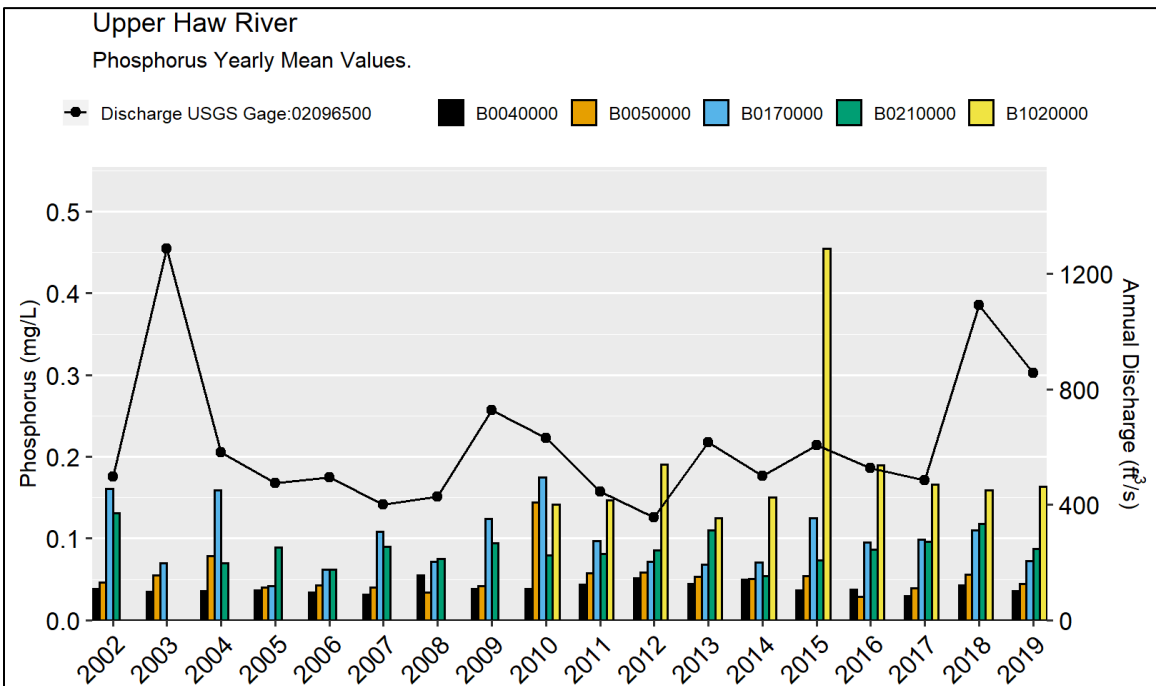
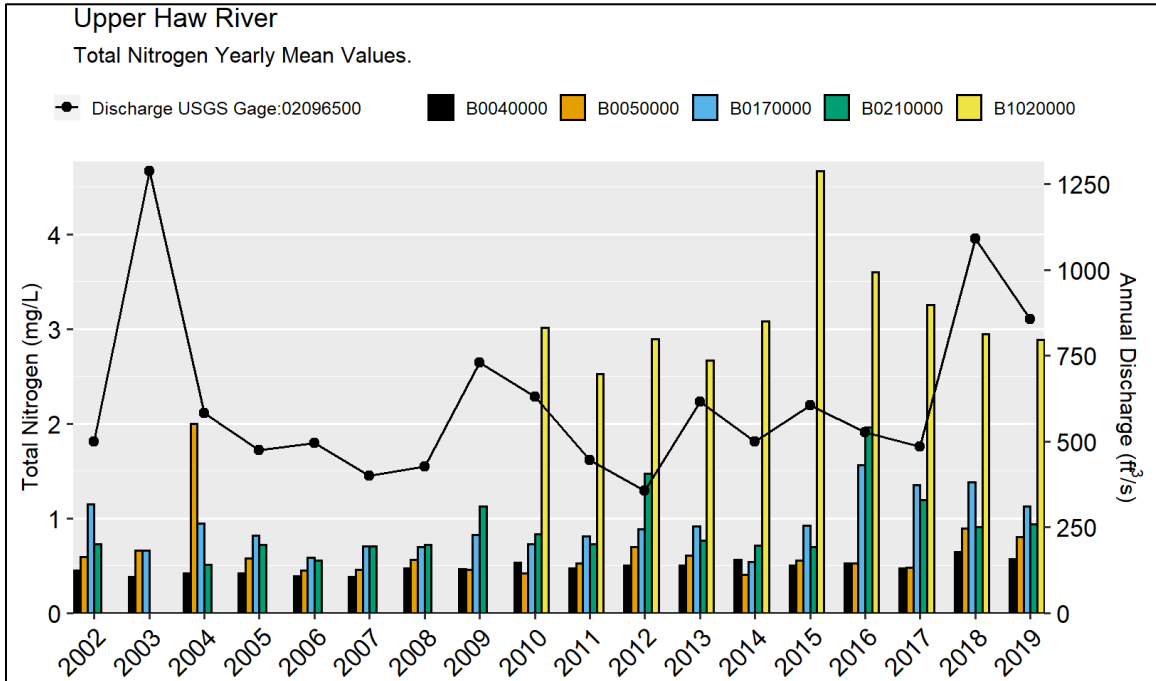
\* DWR conducted a seasonal or nonseasonal Mann-Kendall trend test at most AMS stations that had sufficient data available; reporting only significant increasing or decreasing trends, calculated at 95% confidence from data collected from 2000-2019 and 2010-2019.

For Non-detects or records below the detection limit, the detect limit value is used in the overall summary means and half the detection limit for trends analysis.

The upper reach of the Haw River [AU# 16-(1)a] from the source to Eversfield Rd. (SR 2109) is currently (2022 IR) impaired for aquatic life beneficial uses, which was identified by the most recent Fair bioclassification obtained in 1998 at station BB006 (*Table 6-24*). It was noted at the time of sampling that instream habitat consisted of 80% sand, which may have contributed to the low rating; the total habitat assessment score for the site was 47 out of a possible 100. The ambient monitoring station B0040000 is situated at this same location. The headwaters of the Haw River have relatively low nutrients with a 2022 IR TN concentration of 0.55 mg/L (*Table 6-27*). The yearly mean TN and TP concentrations have been fairly consistent with a slight increase in TN in 2018 and 2019 (*Figure 6-59*). The screening level Mann-Kendall trend analysis (calculated at 95% confidence) suggests that all three nitrogen constituents (NOx, TKN and NH3) have seasonal significant increasing trend for data collected between 2000-2019 and NOx has seasonal significant increasing trend for data collected from 2010-2019 (*Table 6-27*). The fecal coliform bacteria concentration is elevated with a mean of 227 cfu/100 mL.

The Haw River continues to flow northeast until the river meets Troublesome and Little Troublesome creeks. The Haw River [AU# 16-(1)c1] directly upstream of the confluence with Troublesome Creek has remained impaired for aquatic life since 2008 due to a historic total copper metals assessment at station B0050000 (*Table 6-24*). This is a co-located ambient monitoring station. This segment of the Haw River [AU# 16-(1)c1] will be reassessed for dissolved metals when resources allow to verify the copper impairment. The combination of agricultural land use and highly erodible soils have been identified in past basin plans as producing widespread nonpoint source problems in the upper Haw River and Troublesome Creek watersheds.

Figure 6-59: Annual total nitrogen and total phosphorous concentrations along the upper reaches of the Haw River with discharge from a Haw River USGS stream gage.



The southeast portion of the Haw River flows through a rural portion of the watershed with the land use divided between forest (~45%) and agriculture (~31%). Two-thirds of the agriculture is classified as pasture and hay and the other one-third is crop land (2019 NLCD).

After the confluence with Little Troublesome Creek, there are two biological monitoring stations (BB005 and BB163), located on the Haw River before the river leaves the Headwaters Haw River subwatershed (*Figure 6-12*). Both of these biological monitoring stations have received Good-Fair bioclassifications for all sampling events following the 1998 sample collection. Between the two stations, the drainage area increases from 160 square miles to 188 square miles, stream-width increases from 9 meters to 20 meters, and the stream depth increases from 0.3 meters to 0.5 meters. Site BB005 is seven miles south-southeast of Reidsville in the southeast corner of Rockingham County, and directly above the outfall for the City of Reidsville WWTP. There was little change in the EPT BI between the 1998 and 2008 basinwide sampling events.

BB006	
Year	Bioclassification
1998	Fair
BB005	
1998	Fair
2008	Good-Fair
BB163	
2003	Good-Fair
2008	Good-Fair
2013	Good-Fair

Three more EPT taxa were collected during the 2008 sampling event; an additional taxon would have resulted in a classification of Good for 2008. Station BB005 has not been resampled since the 2008 sampling event. Benthos community station BB163 is 7.5 miles northwest of downtown Burlington in northwest Alamance County, and directly downstream of a low-head dam (Glen Raven Mills Dam). Since 1993 the number of EPT taxa collected has declined with each successive sampling event. However, NCBI values have not shown such a clear trend, though all three values since 1993 are higher than the value for 1993. Agriculture and residential areas are sources for impact to the stream at the station. The 2013 sampling event recorded the highest EPT taxa since 1993.

An unnamed tributary located east of the town of Osceola drains approximately 1.5 square miles of primarily cultivated crops, hay and forest land cover. There is also new residential development occurring in this catchment. This tributary flows to meet the Haw River between the two Haw River biological monitoring stations. There is one benthic community station on this tributary, BB490, which was sampled as part of a special study in 2007. This small tributary received a Not Impaired bioclassification based on the sampling event.

BB490*	
Year	Bioclassification
2007	Not Impaired
*Special Study	

In 2004, the City of Greensboro requested that a 10-mile segment of the Haw River [AU# 16-(6.5)] from 0.9 miles downstream of Troublesome Creek down to a point 0.1 miles upstream of SR 2712 (Troxler Mill Rd.) and associated watershed be reclassified in order to recognize and allow for the continued use of an existing emergency potable water supply intake on the Haw River. During the drought of 2002, the city received permission to construct and use an emergency intake on the condition the city would pursue a water supply reclassification. The intake is a permanent intake structure that was utilized from October 2007 through April 2008. The Haw River reclassification from WS-V, NSW to WS-IV, NSW [AU #16-(6.5)] and WS-IV, CA, NSW [AU# 16-(10)] was approved by the Environmental Management Commission and went into effect March 2012.

The Haw River is part of a special study on 1,4-dioxane in the Cape Fear River basin. Between 2017 and 2024, three ambient water quality monitoring stations were monitored for 1,4-dioxane in the Headwater Haw River subwatershed.

- Haw River (AU# 16-(6.5); WS-IV) at Troxler Mill Rd. is located in a water supply watershed (WS-IV). There were a total of 70 samples collected at station B4, which ranged between <1-28 µg/L, with 52 or 74% of the samples below the PQL of 1 µg/L (non-detect). Elevated levels of 1,4-dioxane were recorded between 2017 and 2019 with 16 of the 22 (72%) of the readings greater than the PQL with a mean concentration of 6.2 µg/L (n=22; 6 < 1 PQL; range < 1- 28 µg/L). All 16 of these readings are above the EPA's 1-in -a-million ( $1 \times 10^{-6}$ ) 1,4-dioxane health based drinking water risk value of 0.35 µg/L (EPA IRIS, 2013).
- Haw River (AU# 16-(10.5)a, WS-V) at Brooks Bridge Rd, special study station B1 was sampled 69 time which ranged between <1-19 µg/L with 53 or 77% of the samples below the PQL of 1 µg/L (non-detect). Elevated levels of 1,4-dioxane were recorded between 2017 and 2019 with 15 of the 21 (71%) of the readings greater than the PQL with a mean concentration of 5.6 µg/L (n=21; 6 < 1 PQL; range < 1- 19 µg/L). In this segment, elevated levels of 1,4 dioxane are mainly of concern when they are significant enough to impact downstream use designations such as water supplies.
- Haw River (AU# 16-(10.5)b, WS-V) at ambient monitoring station B0210000 near Altamahaw was sampled 69 time which ranged between <1-27 µg/L with 55 or 80% of the samples below the PQL of 1 µg/L (non-detect). Elevated levels of 1,4-dioxane were recorded between 2017 and 2019 with 12 of the 21 (57%) of the readings greater than the PQL with a mean concentration of 7.9 µg/L (n=21; 9 < 1 PQL; range < 1- 27 µg/L). In this segment, elevated levels of 1,4 dioxane are mainly of concern when they are significant enough to impact downstream use designations such as water supplies.

For these sections of the Haw River, the elevated levels of 1,4-dioxane are the result of Significant Industrial Users that discharge to Reidsville's WWTP. The 1,4-dioxane concentration decreased substantially after 2019. DWR issued a notice of violation to the city of Reidsville's WWTP for a discharge of 367 µg/L of 1,4-dioxane on June 12, 2019. The discharge represented a violation of the state's narrative water quality standard by not protecting downstream drinking water facilities at EPA's health advisory level for drinking water ([November 15, 2019 press release](#)). As of December 2025, the State's use of the narrative water quality standard for toxics to address 1,4-dioxane is in litigation, see the details of this in Chapter 13 section 13.5.3). DWR required monthly effluent sampling for 1,4-dioxane at the Reidsville wastewater treatment plant starting in December 2017 and increased to weekly in October 2019.

*DWR will work with upstream dischargers to identify and reduce the source of 1,4-dioxane at the source of the contaminant.* For more information on emerging contaminants, see Chapter 2 (section 2.13.2) and Chapter 13 for summary tables and figures for 1,4-dioxane in the Cape Fear River basin between 2016 and 2024.

The Haw River [AU# 16-(6.5); WS-IV; NSW] is assessed using both biological data (BB005) and ambient data from station B0170000, which is approximately 5 miles downstream from the benthic station. This segment of the Haw River below Troublesome Creek is listed as not rated on the 2022 IR due to elevated turbidity levels between 2016 and 2018 at the ambient station B0170000 and B0210000 (*Figure 6-60*). The yearly percent exceedance of the 50 NTU standard for the last four years of data presented ranged between 8 and 17% (*Figure 6-60*). The overall 2022 IR turbidity excursion rate was 13.3% and 11.1%, respectively. DWR conducted a seasonal Mann-Kendall trend test for turbidity at station B0170000, which resulted in a significant increasing trend and no significant trend at B0210000 (calculated at 95% confidence) in the turbidity for data collected from 2000-2019 (*Table 6-27*).

The lower segment of the Haw River [AU# 16-(10.5)b] was included as part of the 2005 Turbidity and Fecal Haw River TMDL which was applied to the Haw River from NC87 to NC49. The ambient station used to develop the TMDL was B1140000 at NC49, approximately 12.5 miles downstream from B0210000 in HUC 0303000204 (Back Creek-Haw River watershed). A six-week special study in 2004 found that storm events carried a substantial amount of sediment and solid materials from urban as well as agricultural lands.

A significant relationship between turbidity and flow was observed in the Haw River, where urban lands are rapidly expanding (NCDENR, 2005). There was high TSS loading during high and transitional flows (top 30<sup>th</sup> percentile flows) suggesting that the source of turbidity could be from stormwater runoff and stream bank erosion. Because of the soil type in the Haw River watershed, bank erosion often causes high flocculation of clay and silt, thereby creating high turbidity in the river. The study also found that TSS load under natural background conditions stayed under the turbidity standard of 50 NTU in the Haw River. The Headwater Haw River stations' five-year mean turbidity levels are often elevated over those in the official TMDL stream segments, suggesting that similar management measures are needed throughout the upper Headwater Haw River watershed to address stormwater runoff and storm peak flow stream volumes to meet the 2005 TMDL reduction requirements (*Figure 6-61* and *Table 6-27*). It is important to note that stations B1020000 and B1140000 also receive drainage from the entire Reedy Fork watershed as well as Travis and Stony Creek subwatersheds (*Figure 6-4* and *Figure 6-16*).

There is a fecal coliform bacteria TMDL for the same segment of the Haw River (from NC87 to NC49). The TMDL assessment found that the 400 cfu/100 mL bacteria criteria violations occurred at both high and low flows, suggesting that contamination occurred during both wet and dry weather conditions. A Mann-Kendall trend test for fecal coliform bacteria concentrations found a significant non-seasonal increasing trend at stations B0210000 from data collected from 2000-2019 and 2010-2019 (calculated at 95% confidence), indicating that additional measures are needed to achieve the required load reduction to meet the TMDL (*Figure 6-62* and *Figure 6-63*). The watershed fecal coliform bacteria data suggests the need to implement additional management measures upstream as the bacteria concentrations are often higher upstream at station B0170000 as seen in the five-year mean concentration data in *Figure 6-63*.

Figure 6-60: Haw River Annual Average Turbidity Concentration and Percent Exceedance of the Standard (50 NTU) at Stations B0170000 and B0210000 and Stream Flow at Haw River, USGS Gage Station 02096500.

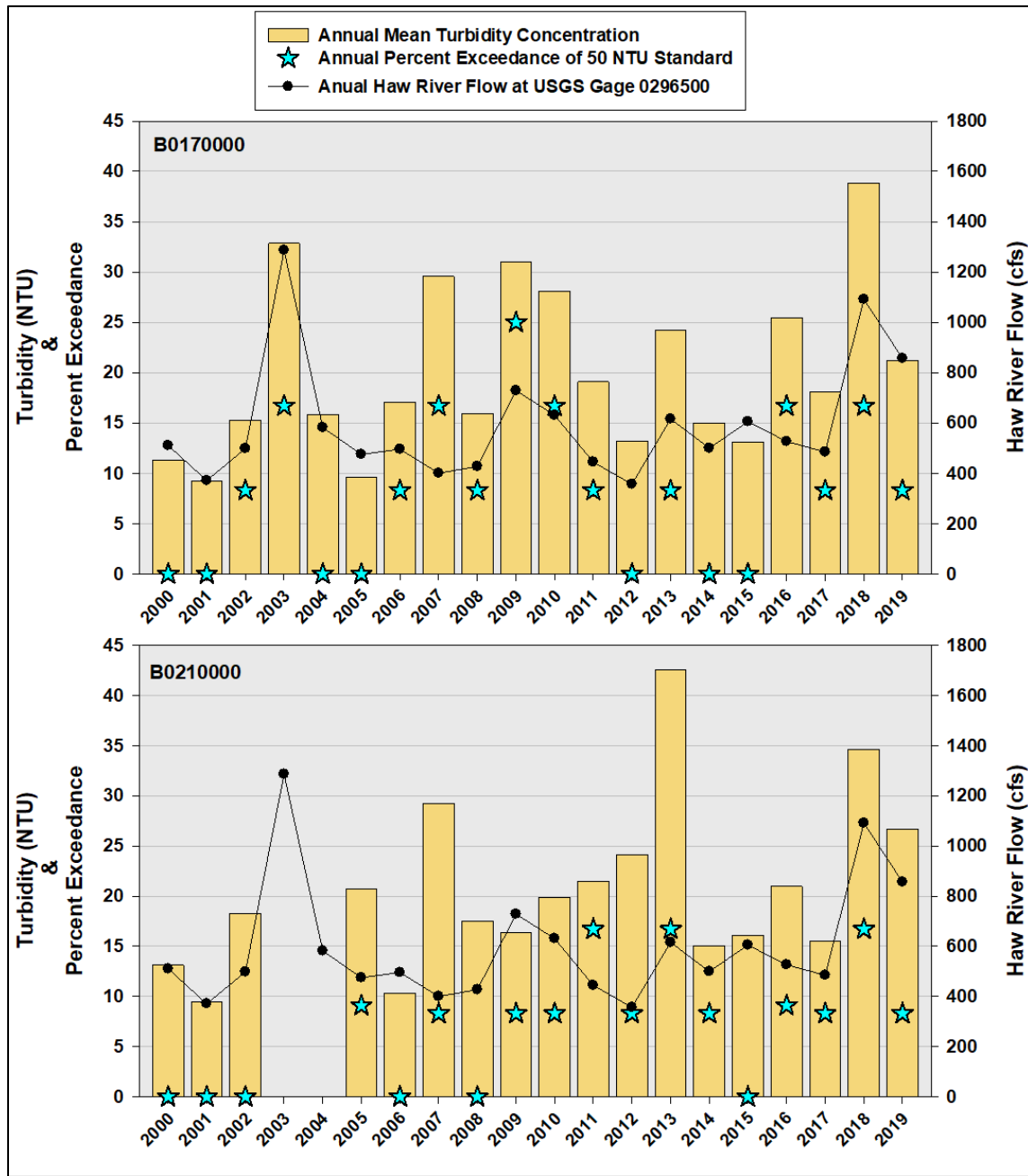
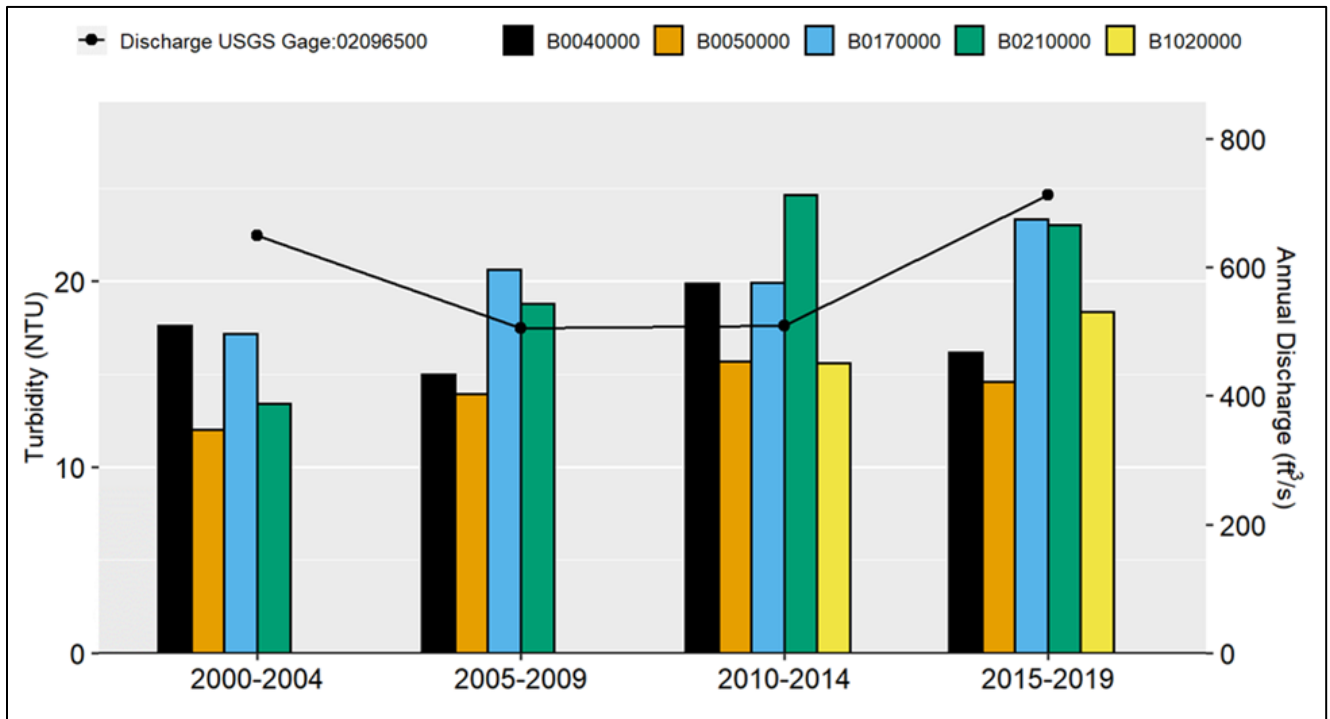


Figure 6-61: Five Year Mean Turbidity Concentration for the Headwater Haw River Stations Between 2000 and 2019 with Corresponding Haw River Flow for stations B0040000, B0050000, B0170000, and B0210000.



The stations include the upstream headwater Haw River station B0040000 (black bar), and B0050000 (orange bar), mid and lower Headwater Haw River stations B0170000 (blue bar) and B0210000 (green bar). Included for reference purposes is the downstream Back Creek- Haw River Watershed (HUC 0303000204), Haw River stations B1020000 (yellow bar) included in the 2005 Haw River Turbidity TMDL. Flow at USGS Gage Station 02096500, Haw River at Haw River (black line with dot).

Figure 6-62: Haw River Annual Average Fecal Coliform Bacteria Concentration and Percent Exceedance of the Standard (400 cfu/100ML) at Stations B0170000 and B0210000 with Stream Flow at Haw River, USGS Gage Station 02096500.

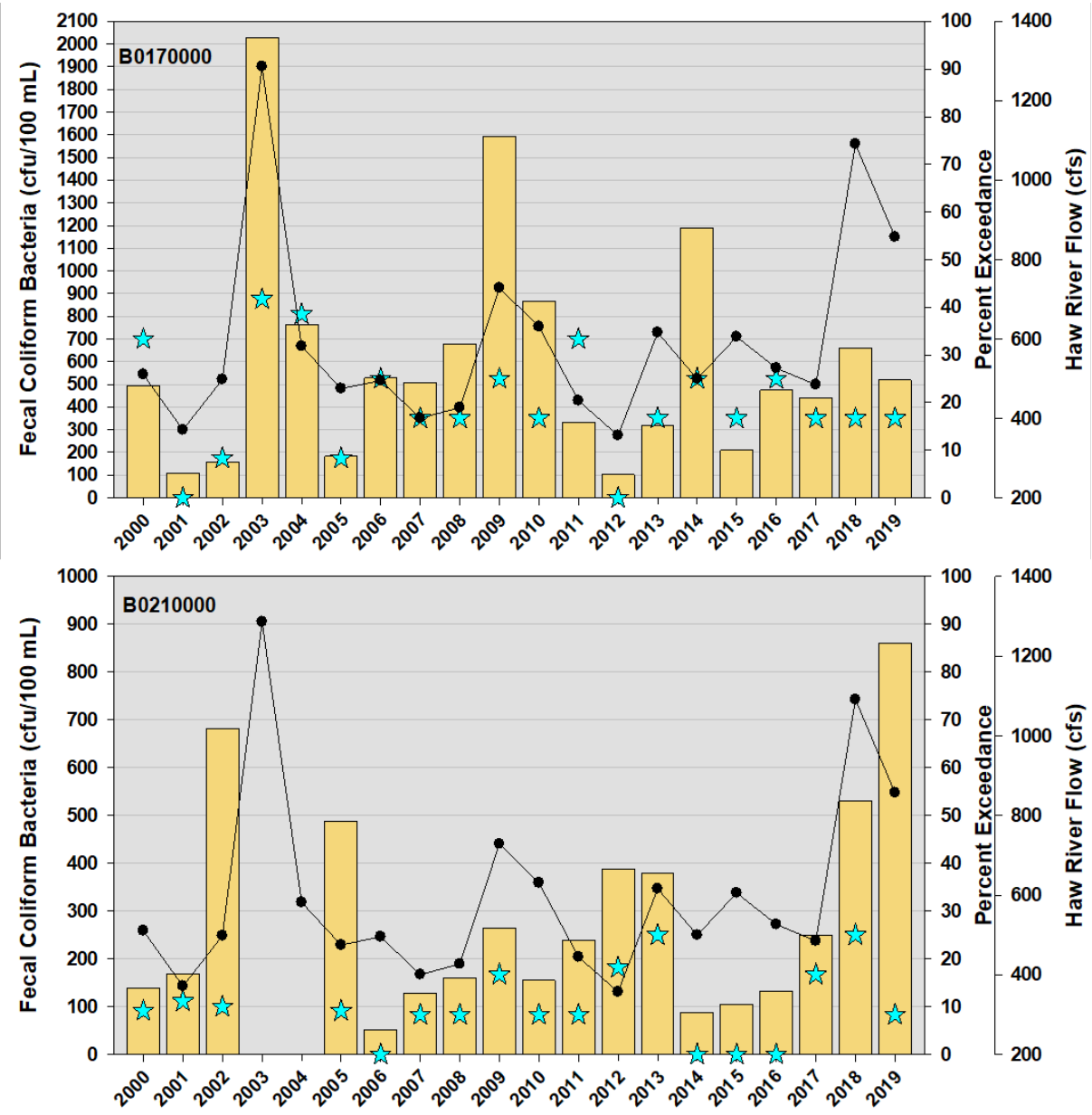
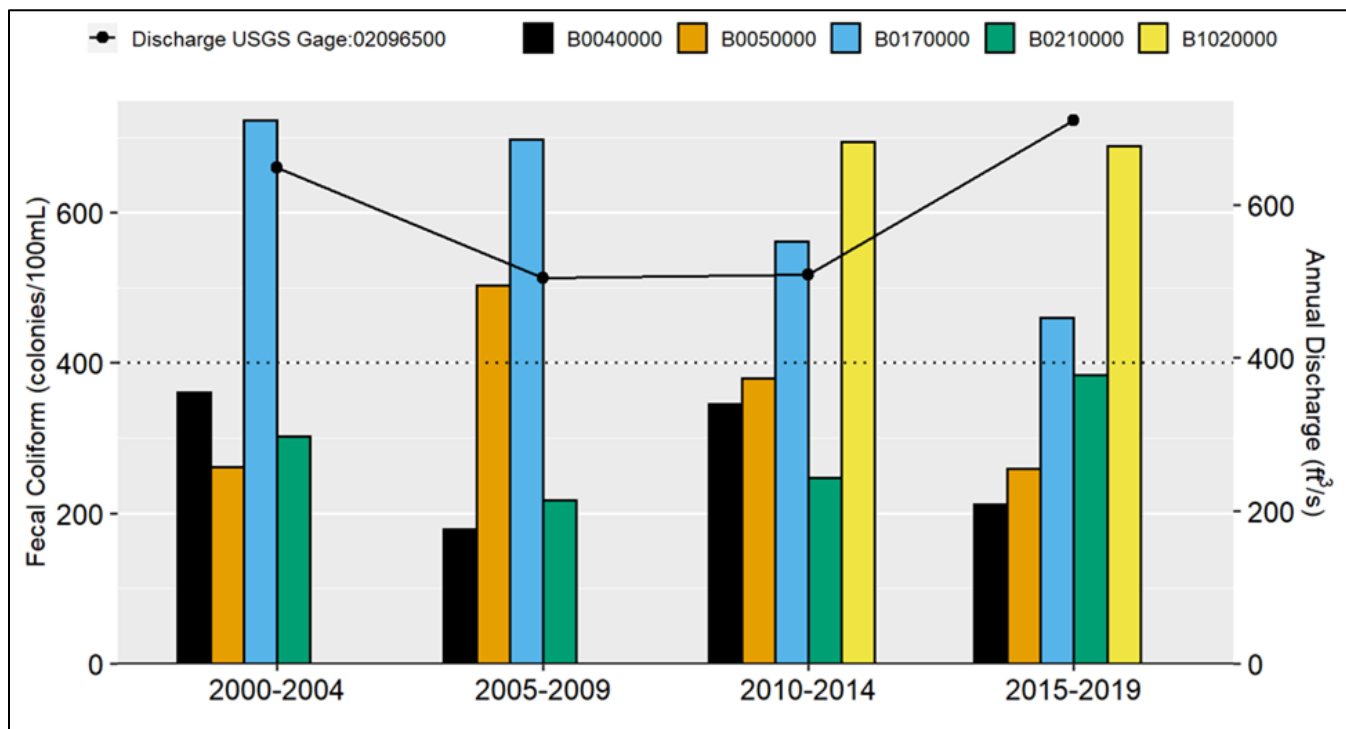


Figure 6-63: Five Year Mean Fecal Coliform Bacteria Concentration for the Headwater Haw River Stations Between 2000 and 2019 with Corresponding Haw River Flow.



The stations include the upstream headwater Haw River station B0040000 (black bar), and B0050000 (orange bar), mid and lower headwater Haw River stations B0170000 (blue bar) and B0210000 (green bar). Included for Reference purposes is the downstream Back Creek- Haw River Watershed (HUC 0303000204), Haw River stations B1020000 (yellow bar) included in the 2005 Haw River Fecal Coliform TMDL. Flow at USGS Gage Station 02096500, Haw River at Haw River (black line with dot).

While the Headwater Haw River watershed has the lowest overall five-year mean nutrient concentrations of all the HUC-10 subwatersheds, the nutrient concentrations generally increase moving downstream as additional sources of nitrogen and phosphorus load is added to the system (*Table 6-10, Figure 6-59* and *Figure 6-64*). The Reidsville WWTP is the only major discharger in the Headwater Haw River subwatershed. As previously discussed above, Reidsville moved their discharge pipe from Little Troublesome Creek to the Haw River in 1998, approximately 5 miles upstream of ambient monitoring station B0170000. This allowed for greater dilution (IWC=61%) and improved water quality conditions in Little Troublesome Creek.

TN and TP concentrations have been relatively consistent throughout the watershed over the last 20 years (*Figure 6-59* and *Figure 6-64*). An increase in instream nitrate concentration at station B0170000 was detected in 2016 in response to the treatment plant modification that resulted in lower ammonia concentrations but higher overall nitrate concentrations in their effluent discharge to the Haw River (*Figure 6-65*) (see section 6.6.2 and *Table 6-21* for more details on the WWTP upgrade). This is also reflected in the increase in the yearly mean TN concentration in *Figure 6-59*, and increase in the five-year

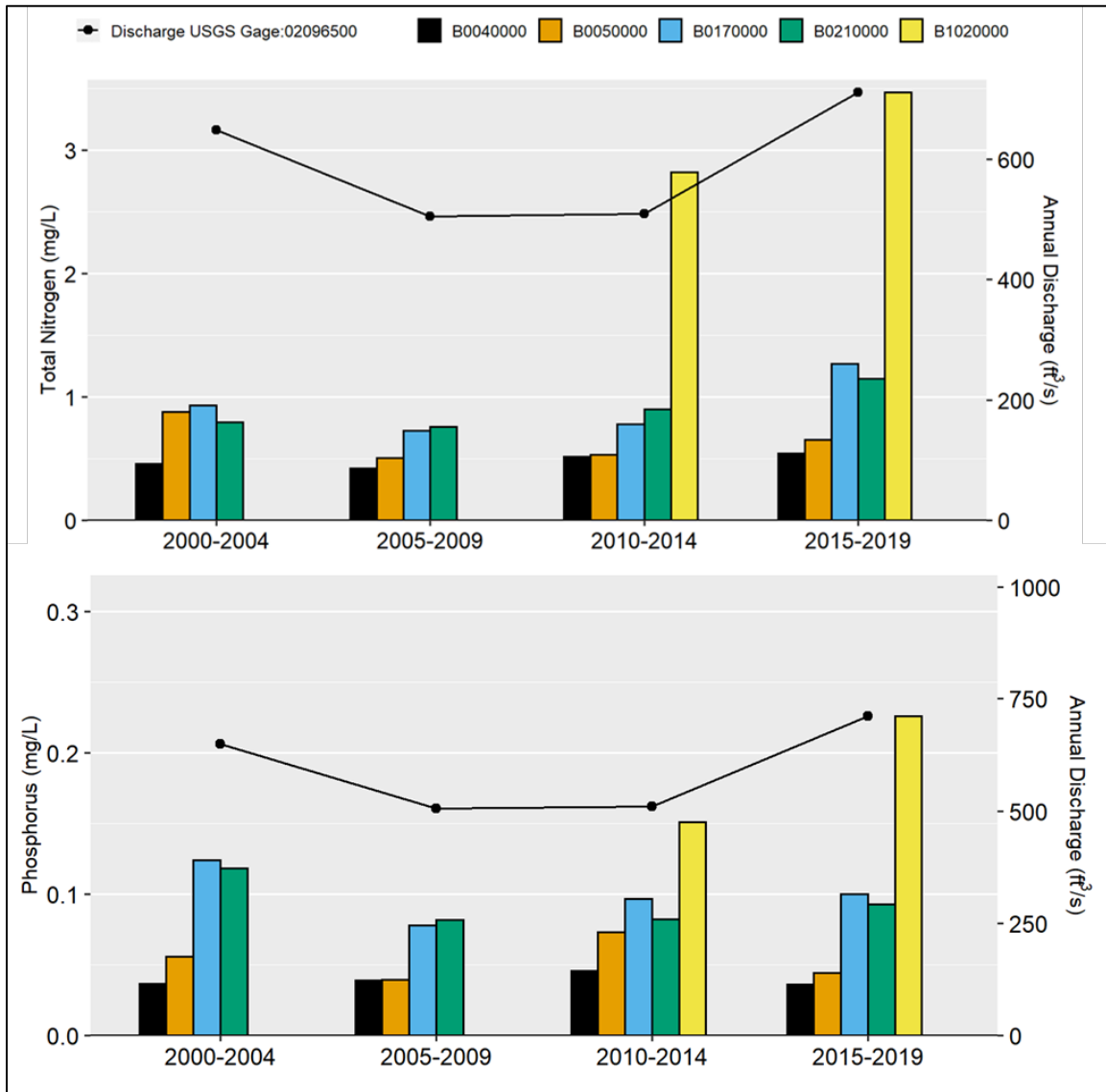
mean TN concentration seen in *Figure 6-64* at station B0170000, and an increase in the two downstream stations B0210000 and B1020000 from 2015-2019 as well as a decline in the ammonia concentration at station B0170000 in this same time period (*Figure 6-66*). The screening level Mann-Kendall trend analysis (calculated at 95% confidence) found a significant increasing seasonal trend in nitrate at station B0170000 for data collected between 2010-2019 and a non-seasonal increasing trend in nitrate at station B0210000 for both time periods (2000-2019 and 2010-2019) (*Table 6-27*). Both stations also recorded a significant seasonal decreasing trend in the ammonia concentrations for 2010-2019 (calculated at 95% confidence).

Interestingly, the highest instream ammonia concentrations in the Headwater Haw River were detected at the most upstream station, B0040000. The source of the higher ammonia at this station is not specifically known but could be associated with septic systems or the two minor permitted point source dischargers into this segment of the watershed: Oak Ridge Military Academy (NC0046043) and a single-family discharge permit. The annual total nitrogen effluent concentrations have been between 20 and 60 mg/L for Oak Ridge Military Academy from 2010-2020. Their reported average nitrate and ammonia concentration over this time period was 32 mg/L and 0.31 mg/L with a range between 2 and 112 mg/L and 0.01 and 11.3 mg/L, respectively (BIMS data query Nov 2021). Oak Ridge Military Academy discharges to an unnamed stream about 3.5 miles upstream from station B0040000.

The Haw River [AU# 16-(10.5)c] leaves the Headwater Haw River subwatershed and enters the Back Creek subwatershed (0303000204) at the confluence with Reedy Fork. The next ambient water quality station, B1020000, is 9 miles downstream of B0210000, the final station in the Headwater Haw River subwatershed. What is most apparent is the increase in the overall instream Haw River nutrient concentrations at the downstream Haw River station, which is impacted by the nutrient contributions from the Reedy Fork (HUC 0303000201, discussed above) and Travis Creek subwatersheds (*Table 6-27*, *Figure 6-59* and *Figure 6-64*).

Overall, ambient water quality along the Haw River section in the Headwaters Haw River watershed reflects a river impacted by developed and agricultural land use. Nutrients (total nitrogen and phosphorus) are relatively low near the headwaters (B0040000); however, nutrients generally increase after receiving water from Candy, Rose, Giles, and Little Troublesome creeks. This increase in nutrients can be seen at stations B0170000 at the High Rock Road bridge and B0210000 at the Hub Mill Road bridge. After station B0210000 the Haw River is joined by Reedy Fork, Travis and Dry creeks. The collective discharge from these streams displays a continued increase in nutrients as the river is viewed going downstream.

Figure 6-64: Five Year Mean Total Nitrogen and Total Phosphorus Concentration for the Headwater Haw River Stations Between 2000 and 2019 with Corresponding Haw River Flow.



The stations include the upstream headwater Haw River station B0040000 (black bar), and B0050000 (orange bar), mid and lower headwater Haw River stations B0170000 (blue bar) and B0210000 (green bar). Included for reference purposes is the next downstream station in Back Creek- Haw River watershed (HUC 0303000204), Haw River stations B1020000 (yellow bar) which captures drainage from Reedy Fork watershed. Flow at USGS Gage Station 02096500, Haw River at Haw River (black line with dot).

Figure 6-65: Haw River Nitrogen Constituent Concentration at Station B0170000 between 2002 and 2019.

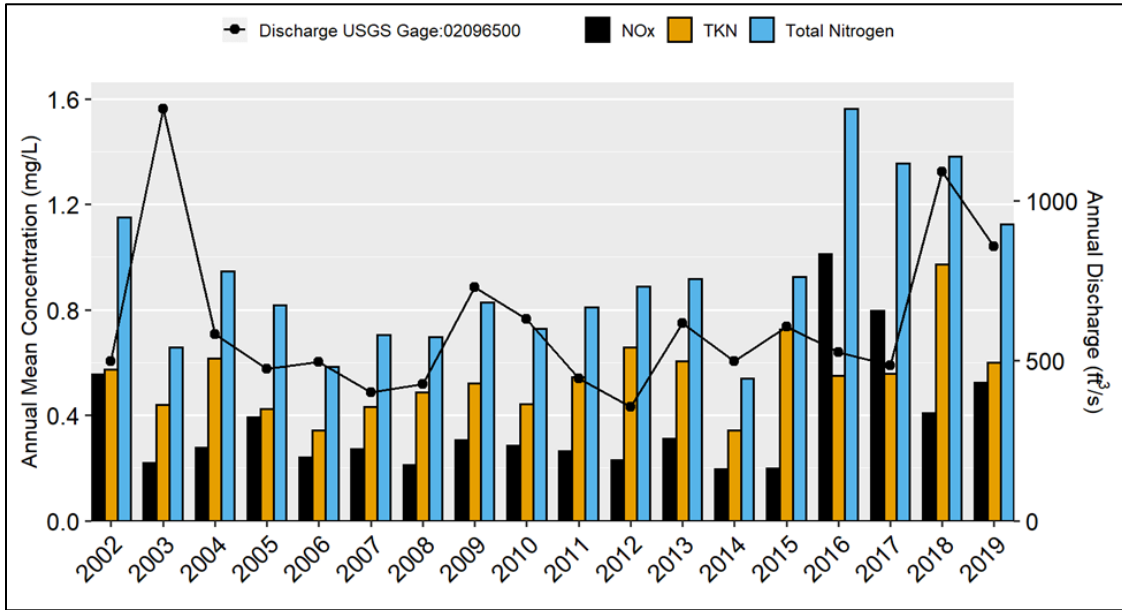
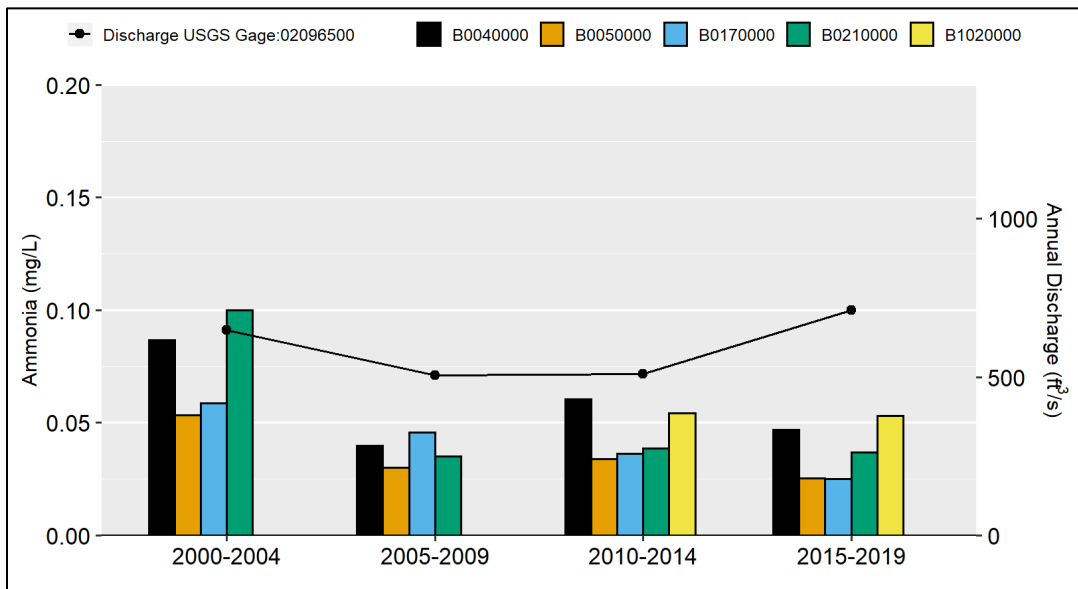


Figure 6-66: Five Year Mean Ammonia Concentration for the Headwater Haw River Stations Between 2000 and 2019 with Corresponding Haw River Flow.



The stations include the upstream headwater Haw River station B0040000 (black bar), and B0050000 (orange bar), mid and lower headwater Haw River stations B0170000 (blue bar) and B0210000 (green bar). Included for reference purposes is the next downstream station in Back Creek- Haw River Watershed (HUC 0303000204), Haw River stations B1020000 (yellow bar) which captures drainage from Reedy Fork watershed. Flow at USGS Gage Station 02096500, Haw River at Haw River (black line with dot).

#### 6.6.2.4 Headwater Haw River Watershed Summary and Recommendations

Best management practices are recommended to address nutrients, fecal coliform bacteria, turbidity/sedimentation and volume control to improve water quality throughout the Headwater Haw River watershed.

The highly erodible soils produce widespread nonpoint source problems in the upper Haw River and Troublesome Creek watersheds. Many of the biological monitoring stations have not been assessed since 1998. When resources allow, it would be helpful to have the headwater biological stations (BB006, BF93 and/or BF61, BB008) reassessed.

The overall instream nutrient concentrations and conductivity levels are much lower than those found in the other 10-digit HUCs in the Haw River/Jordan Lake subbasin (*Table 6-10*). The ambient water quality along the Haw River section in the Headwaters Haw River subwatershed reflects a river impacted by developed and agriculture land use. Nutrients (TN and TP) are relatively low near the headwaters (B0040000); however, nutrients generally increase after receiving water from Candy, Rose, Giles and Little Troublesome creeks. This increase in nutrients can be seen downstream of Reidsville wastewater discharge point at stations B0170000 at the High Rock Road bridge and B0210000 at the Hub Mill Road bridge. After station B0210000, the Haw River is joined by Reedy Fork, Travis and Dry creeks. The collective discharge from these rivers and creeks displays a continued increase in nutrients as the river travels downstream (specifics will be include in Back Creek 0303000204 subwatershed, section 6.6.4).

There are fecal coliform bacteria and turbidity TMDLs in the watershed. The instream water quality data indicates that there is a continued need for implementation measures to address the sources of these pollutants throughout this subwatershed. General trend analysis at the two lower Haw River stations shows an increasing trend in turbidity and fecal coliform bacteria (*Table 6-27*). The fecal coliform bacteria TMDLs indicate that excursions of the standard occurred regardless of flow or season, indicating that there is a need for implementation measures that address fecal coliform bacteria during both wet and dry seasons/conditions. These include collection system repairs to prevent infiltration and exfiltration, repair of failing septic systems, elimination of illicit discharges, sanitary sewer maintenance and prevention programs to eliminate sanitary sewer overflows (SSOs), pet waste education and receptacle programs.

Lake Reidsville is currently (2022 IR) classified as eutrophic, so efforts should be taken in the watershed to reduce nutrients loading from the landscape to reduce the possibility of the lake becoming impaired. The county Soil and Water Conservation Districts should work with landowners to install voluntary measures to address sources of pollution to the water supply reservoir.

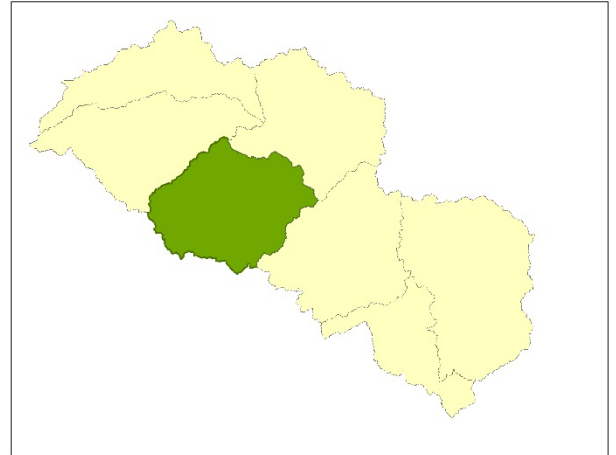
DWR should work with Reidsville's WTP to determine the source of high ammonia concentrations and if this is contributing to the WET test failures over the last several years.

Publicly Owned Treatment Works (POTWs) must work with DWR to determine if their Pretreatment Program is sufficiently evaluating indirect dischargers to protect against accepting waste with potential emerging contaminants.

### 6.6.3 Big Alamance Creek Watershed (0303000203)

Includes: Big Alamance Creek, Little Alamance Creek (Guilford County), Little Alamance Creek (Alamance County) & North and South Prong Stinking Quarter Creek

Big Alamance Creek Watershed HUC 0303000203 has essentially the same watershed boundaries as the old DWQ subbasin 03-06-03. The majority of the development in this watershed has occurred around the I-40/85 transportation corridor, in and around Graham, Burlington and Elon. The headwaters in the western portion of the watershed lie within the outskirts of Greensboro and in the Town of Pleasant Garden. The majority of land cover in this watershed is forest (45%), followed by agriculture (27%) and development (23%) (Table 6-6 and Figure 6-6) (2019NLCD). The watershed is estimated to have a 6.3% impervious cover. The population in this watershed increased by about 16,500 people between 2010 and 2022 to a total of about 114,000 people (Table 6-4).



As of 2022, there is one major and three minor NPDES wastewater discharge facilities permitted for 12.01 MGD, plus an additional four single-family NPDES dischargers (1,560 gpd), five AFOs permitted for 1,695 head count and 513,450 lbs live weight, 249 acres of non-discharge wastewater and residual solids land application fields, as well as 27 NPDES stormwater and six state stormwater facilities. The one major NPDES permit is for the City of Burlington's Southside WWTP (NC0023876) which can discharge 12 MGD into the lower portion of Big Alamance Creek, approximately 0.5 miles above the confluence with the Haw River. This facility is located on the ridge line between Big Alamance and Back Creek - Haw River subwatersheds. AFO facilities include one state swine and four state animal individual facilities. The majority of the permitted fields are residual solids land application fields associated with the city of Asheboro (WQ0001684). The wastewater irrigation fields include five single-family permit fields ranging in size from a quarter to a third of an acre and one facility (the YMCA Camp Weaver WWTP- WQ0019782; 1.6 acres).

For this assessment (2002-2020), there are two ambient stream monitoring stations (one AMS, one UCFRBA coalition), one RAMS, 10 benthic macroinvertebrate stations (including both basin and special study sites) and eight fish community stations used to assess the water quality conditions over this time. Ambient and biology stations discussed in this section were used in the 2022 IR. A complete list of all 2002 to 2020 stations may be found in the Chapter 2 Appendix.

The two ambient monitoring stations are located above (~1.5 miles) and below (~0.4 miles) the Southside WWTP discharge location on Big Alamance Creek (Table 6-28). These stations were used to assess the water quality of this watershed as a whole. Both stations are located at the lower end of the watershed about 2 (B1940000) and 0.1 miles (B1960000) upstream of the confluence with the Haw River (Figure 6-16 and Table 6-28). There was a RAMS station (B1480000) located in the upper portion of Big Alamance Creek and monitored in 2015-2016 only. The Big Alamance 10-digit HUC (0303000203) instream nutrient

concentrations and conductivity levels are lower than the overall 8-digit HUC Haw River/Jordan Lake subbasin (*Table 6-10*). The 2016-2020 mean TN and TP concentration for this HUC-10 was 1.19 and 0.06 mg/L, respectively, compared to 2.10 and 0.13 mg/L for the whole HUC-8 Haw River watershed and 3.35 and 0.19 mg/L for the Reedy Fork watershed, respectively, for comparison (*Table 6-10*). The mean turbidity was however similar at 20.9 versus 20.2 NTU for the HUC-10 and HUC-8, respectively. The fecal coliform bacteria concentration is, however, the highest of all the HUC-10s with a mean of 1,056 cfu/100 mL (*Table 6-10*).

*Table 6-28: Big Alamance Creek (0303000203) Ambient Monitoring Stations Collected by DWR and the Upper Cape Fear River Basin Association Monitoring Coalition.*

Station ID	Station Location	Monitoring Program*	County	Stream AU#	Stream Classification + NSW	HUC 12
B1940000	Big Alamance Creek at NC 87 nr Sweatsonville	UCFRBA	Alamance	16-19-(4.5)b	WS-V	30300020310
B1960000	Big Alamance Creek at SR 2116 at Sweatsonville	AMS	Alamance	16-19-(4.5)b	WS-V	30300020204
B1480000	Big Alamance Creek at Woody Ln off SR 3336 (Coble Church Rd) nr Pleasant Garden	RAMS (2015-2016)	Guilford	16-19-(1)	WS-IV; NSW	30300020301

Monitoring Program\*: AMS = DWR Ambient Monitoring System; UCFRBA = Upper Cape Fear River Basin Association; RAMS= DWR Random Ambient Monitoring System.

The remainder of the 262-square-mile watershed is assessed using biological integrity. Ten biological stations have been assessed since 2002. North Prong Stinking Quarter Creek (2020 IR), Stinking Quarter Creek (2016 IR), and Little Alamance Creek (2000 IR) are impaired for aquatic life based on fish or benthic macroinvertebrate bioclassification ratings of Poor or Fair (IR listing year for each creek) (*Table 6-29*).

The Little Alamance Creek aquatic life impairment is attributed to a complex set of factors found in urban watersheds. The EPA approved an active implementation plan ([4b demonstration](#), TMDL alternative) which is currently being implemented by the cities of Burlington and Graham as well as by NC DOT (specific detail provided in the Little Alamance Creek writeup below) (*Table 6-29*).

*Table 6-29: 2022 IR Water Quality Impairments by Stream Segment (AU#) for Big Alamance Creek HUC 0303000203.*

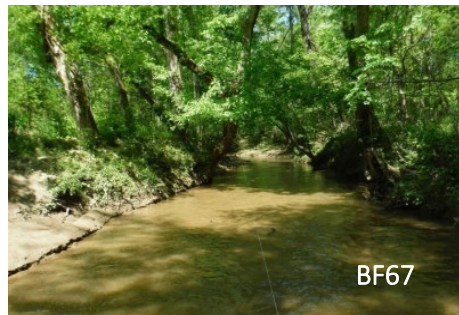
Stream	AU#	Classification	Description	Impairment Parameter (IR category)
North Prong Stinking Quarter Creek	16-19-8-1	WS-V; NSW	From source to Stinking Quarter Creek	Benthos (5)
Stinging Quarter Creek	16-19-8	WS-V; NSW	From source to Big Alamance Creek	Benthos (5)
Little Alamance Creek	16-19-11	WS-V; NSW	From source to Big Alamance Creek	Benthos (4b)

### 6.6.3.1 Little Alamance Creek (Guilford)

Little Alamance Creek (Guilford County) drains the southeast edge of Greensboro, including the I-85, US 421 and NC 22 corridors, and is a tributary to Big Alamance Creek. There are two fish community stations located on this stream. There are two Little Alamance creeks in the Big Alamance Creek watershed. Little Alamance Creek (Guilford County) [AU#s 16-19-3-(0.5) and 16-19-3-(4.5)a] from the source to Rock Creek is currently (2022 IR) supporting aquatic life due to the fish community bioclassification ratings.

Fish community station BF67 [AU# 16-19-3-(0.5)] at Nelson Farm Rd., pictured below, has been regularly sampled since 1998. Mature forested riparian buffers provide good canopy and shading in the sample reach. A pasture borders part of the upper riparian area on one side, but livestock are fenced out. Deeply incised banks continue to contribute sediment (and occasionally trees) to the channel during high flows. The channel is filled with loose sand and bars are common throughout. Accordingly, instream habitats are primarily sandy runs with side snags, undercuts, blowouts and a few stick riffles providing minimal aeration. A limited assemblage of fish was collected in 2018 with the lowest abundance observed here to date (n= 124, a 70% decline from 410 in 2013), and a net loss of three species since the last basin cycle in 2013.

BF67	
Year	Bioclassification
2003	Good-Fair
2009	Good-Fair
2013	Good-Fair
2018	Good-Fair
BF98	
2004	Good



Most notably, the highfin shiner (an intermediately tolerant minnow, primarily a pool and run occupant) was not encountered in 2018, though 81 were collected in 2013 (making it the second most abundant species). Turbidity increased markedly during the 2018 sample. Reduced visibility could possibly contribute to the lower number of species collected; however, the overall rating remained Good-Fair. Species with young-of-year present in 2018 include bluehead chub (n=4), bluegill (n=58), tessellated darter (n=2), and speckled killifish (n=6). There are 17 known fish species in this small catchment, but no pollution intolerant species, and only one sucker (white sucker, absent in 2018). Overall, this urban watershed has maintained consistent habitat scores, NCIBI metric scores, and its Good-Fair rating over a 20-year period.

Fish community station BF98, about 9.5 miles downstream in segment AU# 16-19-3-(4.5)a at Rock Creek Dairy Rd., was sampled once in 2004 as part of an NC State University fish community response to urbanization study (unpublished data). The site rated Good.

### 6.6.3.2 Little Alamance Creek (Alamance County)

The Little Alamance Creek (Alamance County) watershed is located in Alamance County and is approximately 15.9 square miles in size and includes portions of the cities of Burlington and Graham. Little Alamance Creek flows southeast into Big Alamance Creek approximately three miles upstream of the confluence with the Haw River. This is a highly urbanized watershed with no permitted dischargers.

In 2000, Little Alamance Creek was identified as impaired based on a Poor benthic macroinvertebrate bioclassification rating (*Table 6-29*). Water quality studies attributed the impairment to multiple factors that are typical of the complex conditions found in many urban watersheds, including hydromodification, insufficient riparian buffers, streambank erosion, pollutants in stormwater runoff and degraded instream habitat ([Little Alamance Creek 4b Demonstration Plan, Dec. 2014](#)). In 2015, the EPA accepted an [implementation plan](#) proposed by the cities of Burlington and Graham with NC DOT in conjunction with NC DWR ([EPA Letter, 2015](#)). This is an alternative approach to a TMDL which focuses on active implementation by the entities involved to achieve water quality goals, which in this case is supporting biological integrity (benthic macroinvertebrate and fish communities) throughout this watershed. Biological integrity specifically means “the ability of an aquatic ecosystem to support and maintain a balanced and indigenous community of organisms having species composition, diversity, population densities and functional organization similar to that of reference conditions” ([15A NCAC 02B.0202](#), 2019).

The following were determined to be the significant causes of impairment in this watershed (directly from EPA approval letter, 2015).

- Stormwater runoff due to high levels of impervious surfaces and lack of stormwater control: High conductivity measurements across the watershed are indicative of a mixture of pollutants from urban runoff. The benthic macroinvertebrate data lacked specific indicator taxa but rather exhibited highly pollution tolerant benthic communities, suggesting considerable impacts from urban/suburban pressures. The stream bank erosion and sedimentation associated with these events contribute to habitat degradation associated with biological impairment. **The lack of stormwater treatment and control was found to be the most pervasive stressor in the watershed.**
- Hydromodification (resulting from riparian vegetation removal): Many of the benthic community sites noted significant lack of riparian vegetation areas. Hydrologic changes, due to channelization and large amounts of impervious surface, have degraded instream habitat. This was identified as a secondary stressor.
- Hydromodification (resulting from channelization): Many of the benthic community sites evidenced previous or historical channelization of the stream. Hydrologic changes, due to channelization and large amounts of impervious surface, degrade instream habitat. This was also identified as a secondary stressor.

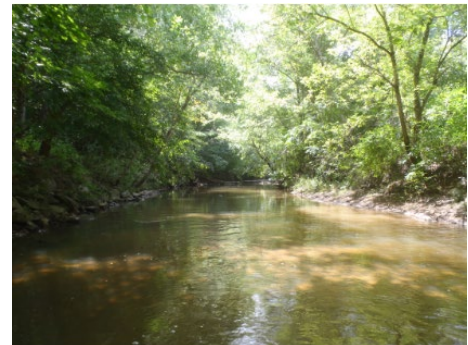
The lack of stormwater treatment and control was found to be the most pervasive stressor in the watershed. (Basin Planner will work with plan partners to append information about the activities in Little Alamance Creek watershed to address the impairment and support additional actions to improve water quality.)

<b>BB042 (UT)*</b>	
<b>Year</b>	<b>Bioclassification</b>
2003	Not Rated
<b>BB193*</b>	
2003	Poor
<b>BB047*</b>	
2006	Poor
<b>BB046*</b>	
2006	Poor
<b>BB078*</b>	
2003	Poor
<b>BB131*</b>	
2003	Poor
<b>BF60</b>	
2003	Good
2009	Good
2013	Good-Fair
<b>BB388</b>	
2003	Fair
2006	Poor
2008	Not Rated
2013	Fair
2018	Fair
*Special Study	



Fish community site BF60 was last sampled in 2013. The site is ~2.6 miles above the creek's confluence with Big Alamance Creek and has the greatest percentage of developed land and least percentage of forested land of any fish community site in the basin that was assessed in 2013. Urban debris was observed in the channel, along the banks, and in the flood plain. The stream is hydrologically flashy due to its developed watershed and severe sloughing of the right bank was present near the beginning of the reach. Elevated specific conductance, 156-186  $\mu\text{S}/\text{cm}$ , is indicative of stormwater and nonpoint source runoff. In 2013, there was a six-point decline in NCBI score and one rating class decline resulting from the number of fish decreasing by 37% between 2009 and 2013. There was a very low percentage of species with multiple age classes which is often seen in populations recovering from drought or high flow effects. In addition, there was a moderately high percentage of diseased fish (1.79%, bluegill with popeye disease). There are 28 species known from the site, including six species of sunfish and five nonindigenous species, but no intolerant species. Over the past three cycles the diversity (total species; species of darters, sunfish and suckers) and trophic metrics (omnivores plus herbivores and insectivores) have been stable, but the number of fish has declined by 56% (224 versus 515) and the percentage of tolerant fish has increased (19% to 30% to 43%).

Little Alamance Creek benthic community site BB388 is co-located with the above fish site BF60, at SR 2309 (Rogers Rd.), south of Graham, NC. The catchment drains heavily developed dense residential areas in Burlington. This sampling reach received a Fair bioclassification in 2018 and has received Poor or Fair ratings since sampling began in 1985. The NCBI (7.1) was the highest index observed at this station since sampling began in 1985. These consecutively high NCBI's ranging from 6.68 to 7.1 and low EPT richness (5 to 8) values suggest a mostly tolerant benthic fauna and chronically degraded stream. Specific conductance has also remained high throughout sampling years along with high amounts of periphyton noted both in 2013 and 2018. This is likely due to nutrient enrichment from upstream nonpoint sources. Additionally, the stream suffers from severe erosion and obvious flashy flows.



*DWR supports and encourages the cities of Burlington and Graham along with NC DOT to work together to implement the Little Alamance 4b implementation plan.*

6.6.3.3 North and South Prong Stinking Quarter Creek; Stinking Quarter Creek

North Prong Stinking Quarter Creek (AU# 16-19-8-1; WS-V;NSW) from the source to Stinking Quarter Creek is currently (2022 IR) impaired due to an April 2018 Poor fish bioclassification rating at BF135 located at Clapp Mill Rd. (Table 6-29). The stream drains southeastern Guilford and western Alamance counties and is a tributary to Big Alamance Creek (converging about 5 miles downstream) and, ultimately, the Haw River. Field biologists noted mature forested riparian areas along both margins, providing equal sun and shade to the creek. The stream channel is entrenched in the sample reach, with scoured banks throughout. Instream habitats include deep boulder and bedrock pools, sandy runs with coarse woody debris, side snags and undercuts. No riffles were present in the reach. A lower diversity assemblage was collected in 2018, showing further decline since the 2013 survey. The fish community is now dominated by three tolerant insectivores including eastern mosquitofish, redbreast sunfish and green sunfish. Fifty percent of the fish species collected in 2018 were represented by only one individual species; however, new records were collected for flat bullhead (n=1), and margined madtom (n=1). Species with young-of-year cohorts in 2018 - redbreast sunfish (n=38). bluegill (n=1), speckled killifish (n=5), crescent shiner (n=2), and bluehead chub (n=1). Similar water quality measurements have been collected in all three basin assessments since 2009, but the fish community has shifted to a few dominant taxa that are tolerant to pollution and low flows. NCIBI scores and ratings have steadily declined in the three fish community assessments here.



BF135	
Year	Bioclassification
2009	Good
2013	Good-Fair
2018	Poor

South Prong Stinking Quarter Creek [16-19-8-2-(2)] was assessed for biology at fish community site BF28. South Prong drains the extreme southeast corner of Guilford County, northeastern Randolph County and southwestern Alamance County, and is a tributary to Stinking Quarter Creek. Site BF28 was last sampled in 2018, when it was rated Good-Fair. It had good forested riparian buffers on both sides of the stream, providing good instream shading. Instream habitats were primarily sandy runs with common woody debris, side snags, good pools with a variety of sizes and some stick riffles. Substrates were nearly all sand. No apparent changes to habitats were noted since the last sampling cycle in 2013, when the site rated Excellent. In 2018, four fewer species and less than 1/4 of the total abundance was observed as compared to past assessments (n=105 in 2018 versus 484 in 2013, 470 in 2009, and 442 in 2003). However, the intolerant piedmont darter was collected for a third time here in 2018 (n=1). Overall, the 2018 sample dropped 16 NCIBI points and two bioclassifications from Excellent in 2013 to Good-Fair in 2018, mostly due to the lower overall community abundance, but also because of the absence of sucker species (white suckers and creek chubsuckers were both collected in 2013 and 2009). A trophic shift



BF28	
Year	Bioclassification
2003	Excellent
2009	Good
2013	Excellent
2018	Good-Fair

toward insectivores was seen in 2018. Species with young-of-year in 2018 included redbreast sunfish (n=37), bluegill (n=1), speckled killifish (n=6), crescent shiner (n=8), bluehead chub (n=10), white shiner (n=5), swallowtail shiner (n=26), and tessellated darter (n=2).

Historically, this is a highly diverse site, with 28 species known from this location. Although still showing good diversity in 2018 (notwithstanding the loss of 4 taxa), and similar water quality measurements over three basin cycles, this stream is currently not supporting the abundance of fish that it did during the last three assessments (all with greater than 400 fish each). This watershed may be more prone to flow extremes than previously assumed (much like the adjacent North Prong Stinking Quarter catchment) and would have been designated for resampling in 2019 if not for the Good-Fair rating. This site should be resampled in the future.

Stinking Quarter Creek (AU# 16-19-8; WS-V; NSW) from the confluence with North and South Prong Stinking Quarter Creek to Big Alamance Creek is currently impaired (2022 IR) due to a July 2013 Fair benthic macroinvertebrate bioclassification rating at BB249, located at Bellemont Mt Herman Rd (*Table 6-29*). This creek receives water from the North Prong Stinking Quarter, South Prong Stinking Quarter and Rock creeks as well as several other small unnamed tributaries. The watershed is located primarily in southwestern Alamance County although a small minority of the watershed is also located in southeastern Guilford County. This stream has been extensively sampled over the course of the past 10 years and in multiple seasons. Stinking Quarter Creek has not been identified as seriously deficient in macroinvertebrate habitat at BB249 over the past 10 years although it has been somewhat variable, and erosion has been a problem. Benthic sampling during summer 2003 occurred after a high flow event suggesting scour may have contributed to low EPT richness for that year. EPT richness was higher during the subsequent two sampling events even with seasonal adjustments; however, the most recent EPT richness levels from summer 2013 were equal to summer 2003 levels. The Fair rating in 2003 was most likely due to effects from the 2002 drought and is supported by the absence of edge species in the sample. This small tributary received a Not Impaired bioclassification based on the sampling event. The odor of sewage was noted during 2013. As there are no permitted NPDES wastewater treatment plants on this stream or its tributaries, the sewage odor could indicate either failing septic fields, leaking sewer pipes or could be from animal waste. The bioclassification of Stinking Quarter Creek fell to Fair for 2013.

<b>BB505</b>	
<b>Year</b>	<b>Bioclassification</b>
2009	Good-Fair
<b>BB249</b>	
<b>Year</b>	<b>Bioclassification</b>
2003	Fair
2003	Good-Fair
2013	Fair

In 2009, due to deep water and no flow at the original basin station BB249, the monitoring effort was moved upstream to BB505, which is approximately 0.5 miles from the confluence of North and South Prong Stinking Quarter Creek at Dr. Pickett Rd. In order to find a station that was wadable and had sufficient flow, the station had to be moved several miles upstream and above the confluences of Little Alamance Creek and Rock Creek. This reduced the drainage area from 81.0 square miles at the SR 1136 (Bellemont Mt Herman Rd) location to 62.2 square miles at the new location. This station received Good-Fair ratings the only time it was sampled in 2009.

#### 6.6.3.4 Big Alamance Creek

Big Alamance Creek [AU# 16-19-(1); WS-IV; NSW] from the source to a point 2.4 miles downstream of Guilford County SR 3045 is currently (2022 IR) rated as data inconclusive (DI or not rated) due to low dissolved oxygen in 11% of the samples collected as part of the 2015-2016 RAMS study at station B1480000 (at Big Alamance Creek at Woody Ln off SR 3336 (Coble Church Rd) near Pleasant Garden).

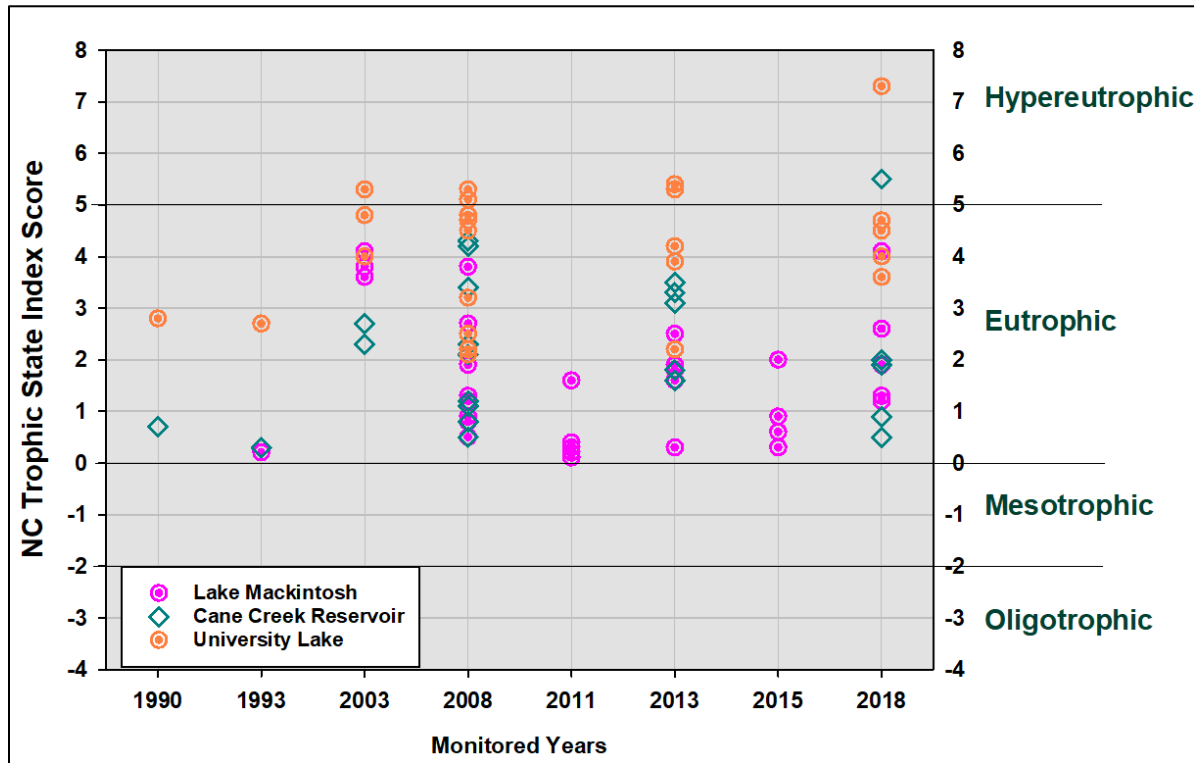
In 2018, fish community site BF68 saw a shift of nine species (three gains and six losses) since the 2013 assessment at the Thacker Dairy Rd location. DWR also collected the threadfin shad (*Dorosoma petenense*), a spring visitor from Lake Mackintosh, for the first time. Overall, there was a 10-point drop in the NCIBI score resulted in a rating drop to Good-Fair on account of a 45% decrease in total abundance (163 collected in 2018 vs. 296 in 2013) and three fewer species present (including no suckers, collected in all previous samples) and no intolerant species (piedmont darter has not been observed here since 1999). However, no fish diseases were observed, and several species were represented by young-of-year cohorts in 2018 – redbreast sunfish (n=22), bluegill (n=6), green sunfish (n=1), flat bullhead (n=1), bluehead chub (n=9), tessellated darter (n=4), highfin shiner (n=4), creek chubsucker (n=1), swallowtail shiner (n=2), and speckled killifish (n=2). There are now 30 fish species known from this watershed. The 2018 NCIBI score is the lowest springtime score seen here to date. However, water quality parameters and a Good-Fair rating in 2018 are not unlike past assessment results. Biologists continue to report that the fish community here is likely influenced by flow extremes and recruitment restrictions presented by Lake Mackintosh. Overall, the fish community continues to indicate relatively stable water quality in this mixed-use catchment.



BF68	
2009	Good-Fair
2013	Good
2018	Good-Fair

The Big Alamance Creek catchment is located in southeastern Guilford County and western Alamance County. This stream drains suburban portions of Greensboro and Burlington, and was impounded in 1993 forming Lake Mackintosh Reservoir, a main water supply for the city of Burlington. Big Alamance Creek/Lake Mackintosh [AU# 16-19-(2.5); WS-IV; NSW, CA] from a point 2.4 miles downstream of Guilford County SR 3045 to the dam at Lake Mackintosh is currently (2022 IR) rated as data inconclusive due to insufficient data collected for all parameters over the last two monitoring events in 2013 and 2018. The lake was sampled monthly from May through September 2018 and has been found to be consistently eutrophic since it was first monitored in 1993 when the lake was filled (*Figure 6-67*). The highest chlorophyll *a* concentrations occurred in May 2018 with reading ranging from 14 to 42 µg/L at the six stations sampled. The turbidity levels were also high (5.2-22.0 NTU) and the Secchi depths were very low at all but one station (0.5 to 1.2 m) ([Oct. 2018 ISB Report](#)).

Figure 6-67: Haw River Watershed Lake Trophic Status (NCTSI) for Lake Mackintosh, Cane Creek and University Reservoir.



Yearly average (1990s) or monthly lake NCTSI average (2000 to present) are presented (data from WSS/ISB Lakes Program, January 2020).

Big Alamance Creek [AU# 16-19-(4.5)a; WS-V; NSW] from the dam at Lake Mackintosh to the confluence with Stinking Quarter Creek is supporting aquatic life due to an August 2018 Good-Fair benthic macroinvertebrate bioclassification rating at station BB130. The stream segment was added to the 303(d) impaired waters list in 2006 for impaired biological integrity. The benthos community (BB130) displayed a reduction in the number of EPT taxa collected, suggesting that water quality at the station deteriorated in 2008. Development and agriculture in the watershed are likely sources of impact to the benthic community. Biological sampling in 2013 resulted in the most EPT taxa seen in this segment of the stream. Many silt-loving mayflies have been abundant since 1993, indicating that the creation of the reservoir in 1991 may have released significant amounts of sediment, although agriculture and development certainly contribute sediment as well. A substantial drop in the 2013 EPT BI value over 2008 indicates a more intolerant community has recently been established. While deficient in habitat, Big Alamance Creek was rated Good-Fair for the first time since 1998. The biological community had recovered enough to remove Big Alamance Creek from the NC 303(d) impaired waters list in 2014.

BB130	
Year	Bioclassification
2008	Fair
2013	Good-Fair
2018	Good-Fair

EPT richness (14) declined in 2018 compared to in 2013 (EPT = 20), however the sampling station retained its Good-Fair bioclassification. One less EPT taxon would have resulted in a Fair bioclassification at this Big Alamance Creek sampling station. No specimens of the mostly intolerant aquatic insect Order Plecoptera (stoneflies) have been collected from this sampling station since 2003. There are no NPDES permitted dischargers upstream of this sampling location. The low EPT richness (14) and slightly elevated EPTBI (5.91 in 2018 compared to 5.64 in 2013) suggest the benthic fauna at this location has declined and is slowly becoming more tolerant. Likely factors negatively affecting benthic metrics at this location include increased nonpoint source pollution runoff from upstream impervious surfaces and agricultural land use coupled with high amounts of precipitation in 2018. High water temperature (29° Celsius) was noted in 2018 as would be expected from a stream receiving epilimnetic water from the upstream reservoir in late summer. Elevated temperatures could also be a factor contributing to the more tolerant fauna observed.

Big Alamance Creek [AU# 16-19-(4.5)b; WS-V; NSW] from the confluence with Stinking Quarter Creek to Haw River is currently (2022 IR) listed as data inconclusive due to elevated fecal coliform bacteria concentration (no 5-in-30 completed). The fecal coliform bacteria five-year mean (2016-2020) for the two stations are 1322 and 761 cfu/100 mL (*Table 6-30*). The 2022 IR water quality standard excursion rate (> 400 cfu/100 mL standard) was 33% and 21% for stations B1940000 and B1960000, respectively (2022 IR data – B1940000: GM=312.7 and 33% >400 cfu/100 mL; B1960000: GM=191.9 and 21% >400 cfu/100 mL).

*Table 6-30: Big Alamance Creek Water Quality Ambient Instream 5-year Mean Concentrations (2016-2020).*

Station	TN# (mg/L)	NOx (mg/L)	TKN (mg/L)	NH3 (mg/L)	TP (mg/L)	Fecal C. (cfu/100 mL)	Turbidity (NTU)	Conductivity (µS/cm)	Station Trend* Information 2000-2019 & 2010-2019 Decreasing (↓) or Increasing (↑) Seasonal (S) or Non-Seasonal (NS)	Watershed Information	HUC 10 0303000_ & Stream Class
B1940000	0.92	0.23	0.69	0.03	0.05	1322	21.9	121	TKN - ↑ NS 10-19; Turbidity - ↑ S 00-19 & Turbidity - ↑ S 10-19;	Upstream of City of Burlington WWTP discharge; 259.3 mi <sup>2</sup>	203 WS-V; NSW
B1960000	1.49	0.71	0.78	0.05	0.17	761	19.6	232	NH3 - ↓ NS 00-19 & NH3 - ↓ NS 10-19; TP - ↓ S 00-19; TKN - ↓ S 10-19; Cond - ↓ S 00-19 & S 10-19	Downstream of City of Burlington WWTP discharge; 262.2 mi <sup>2</sup>	203 WS-V; NSW

# TN is calculated as NOx + TKN. Both values were required to develop a TN value.

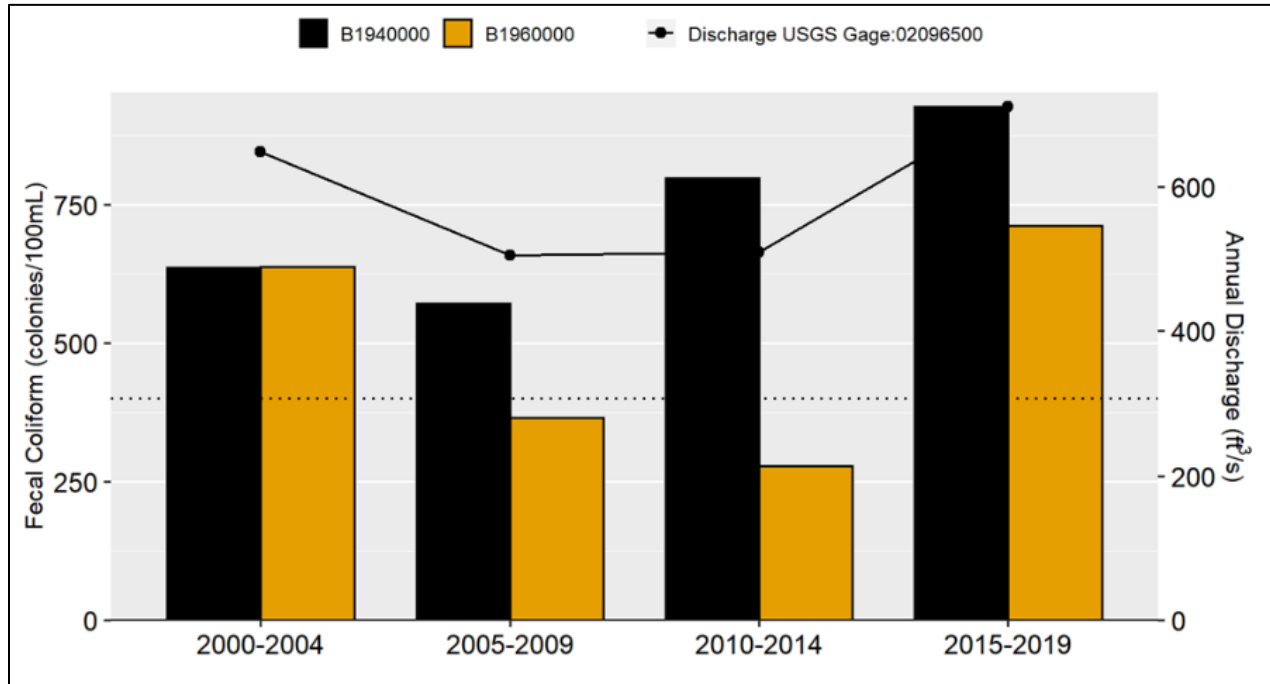
For Non-detects or records below the detection limit, the detect limit value is used in the overall summary statistics.

Note: B1940000 is an UCFRBA coalition station and B1960000 is a DWR AMS station. These stations are not sampled on the same dates.

The fecal coliform bacteria concentrations are generally higher at the upstream B1940000 station (*Table 6-30* and *Figure 6-68*). There is an additional 2.9 square mile drainage area between the two stations and the City of Burlington’s 12 MGD wastewater discharge (*Figure 6-4*). Sources of bacteria are likely similar to those described in the other Har River watersheds which include a multitude of nonpoint sources that contribute during wet and dry periods. Efforts need to be made throughout this watershed to reduce

bacteria contribution to surface waters. Turbidity is also elevated and would benefit from better stormwater controls as well. DWR conducted screening level seasonal Mann-Kendall trend tests at 95% confidence for monitoring data collected from 2000-2019 and 2010-2019 and found an increasing trend in turbidity at the upstream station B1940000 (*Table 6-30*).

Figure 6-68: Big Alamance Creek 5-Year Mean Fecal Coliform Bacteria Concentrations.



The mean nutrient concentration levels at station B1940000 (*Table 6-30*), above the WWTP, are relatively close to the healthy piedmont stream levels as described in *Table 6-10*. The nutrient levels increase below the WWTP discharge point with the five-year (2016-2020) mean for TN concentration increasing from 0.92 mg/L upstream to 1.49 mg/L downstream and TP increasing from 0.05 mg/L to 0.17 mg/L (*Table 6-30* and *Figure 6-69 C* and *E*). There is also an increase in all the nitrogen parameters (NO<sub>x</sub>, TKN and NH<sub>3</sub>) as well as in conductivity at the downstream station. The elevated concentration of these parameters are good indicators that the source is wastewater from the Burlington Southside WWTP (*Figure 6-69*).

There has been an overall reduction in nitrogen and phosphorus concentrations over the last 20 years at B1960000, which is likely due to wastewater treatment plant improvements. DWR conducted a Mann-Kendall trend test at station B1960000 downstream of the WWTP, which resulted in a significant decreasing trend in seasonal TP (2000-2019), TKN (2010-2019) and conductivity (2000-2019 and 2010-2019) and a non-seasonal decreasing trend in ammonia (2000-2019 and 2010-2019) calculated at 95% confidence. Upstream at station B1940000 there is an increasing non-seasonal TKN trend for data collected between 2010-2019 (*Table 6-30*).

The City of Burlington WWTP is subject to the Jordan Lake Water Supply Nutrient Strategy (15A NCAC 02B .0262) which requires a nitrogen and phosphorus TMDL reduction goal of 8% and 5%, respectively, from

the 1997-2001 baseline load. Burlington received a combined allocation for their two treatment plants [Southside WWTP (NC0023876) discharges to Big Alamance Creek and Eastside WWTP (NC0023868) discharges to the mainstem Haw River] for a total nitrogen (TN) allocation of 386,156 lbs/yr (effective January 1, 2018) and 48,540 lbs/yr total phosphorus (TP) (effective January 1, 2010) (*Table 6-31*). Both of Burlington’s wastewater treatment plants have a designed treatment capacity of 12 MGD. The Southside WWTP average flow between January 2018 through August 2022 was 7.5 MGD, with an average TN and TP effluent concentration of 4.8 and 0.3 mg/L respectively. The highest yearly TN load from the Southside WWTP since 2018 when their allocation became effective was 120,268 pounds in 2020 which was well below their individual end of pipe allocation of 193,078 pounds (*Table 6-31*). The City of Burlington joined the Haw River Nutrient Compliance Association (NCC000003) in December 2019. The Association is a legal entity through which the members can work collectively to meet the point source nutrient targets in the Haw River subwatershed.

*Table 6-31: Burlington Eastside and Southside WWTP Annual Total Nitrogen and Total Phosphorus Jordan Lake Allocation and their Yearly Load between 2018 and 2022.*

Nutrient	Burlington WWTPs	End of Pipe Allocation lbs/yr	Delivered <sup>2</sup> Allocation lbs/yr	Delivery Factors	2018 <sup>1</sup> lbs/yr	2019 <sup>1</sup> lbs/yr	2020 <sup>1</sup> lbs/yr	2021 <sup>1</sup> lbs/yr	2022 <sup>1</sup> lbs/yr
<b>Total Nitrogen</b>	Eastside Burlington	193,078	148,670	77%	175,143	172,785	156,417	163,403	159,251
	Southside Burlington	193,078	154,463	80%	116,446	118,746	120,268	101,500	84,407
	<b>Combined Total</b>	<b>386,156</b>	<b>303,133</b>		<b>291,589</b>	<b>291,531</b>	<b>276,686</b>	<b>264,903</b>	<b>243,659</b>
<b>Total Phosphorus</b>	Eastside Burlington	24,270	16,746	69%	5,994	5,913	3,121	3,438	3,007
	Southside Burlington	24,270	17,717	73%	6,496	7,594	9,657	7,108	6,553
	<b>Combined Total</b>	<b>48,540</b>	<b>34,463</b>		<b>12,490</b>	<b>13,507</b>	<b>12,778</b>	<b>10,546</b>	<b>9,560</b>

Jordan Lake nutrient strategy (15A NCAC 02B .0262)

<sup>1</sup> End of Pipe loads reported.

<sup>2</sup> Jordan Lake delivered load allocation based on transportation delivery factors.

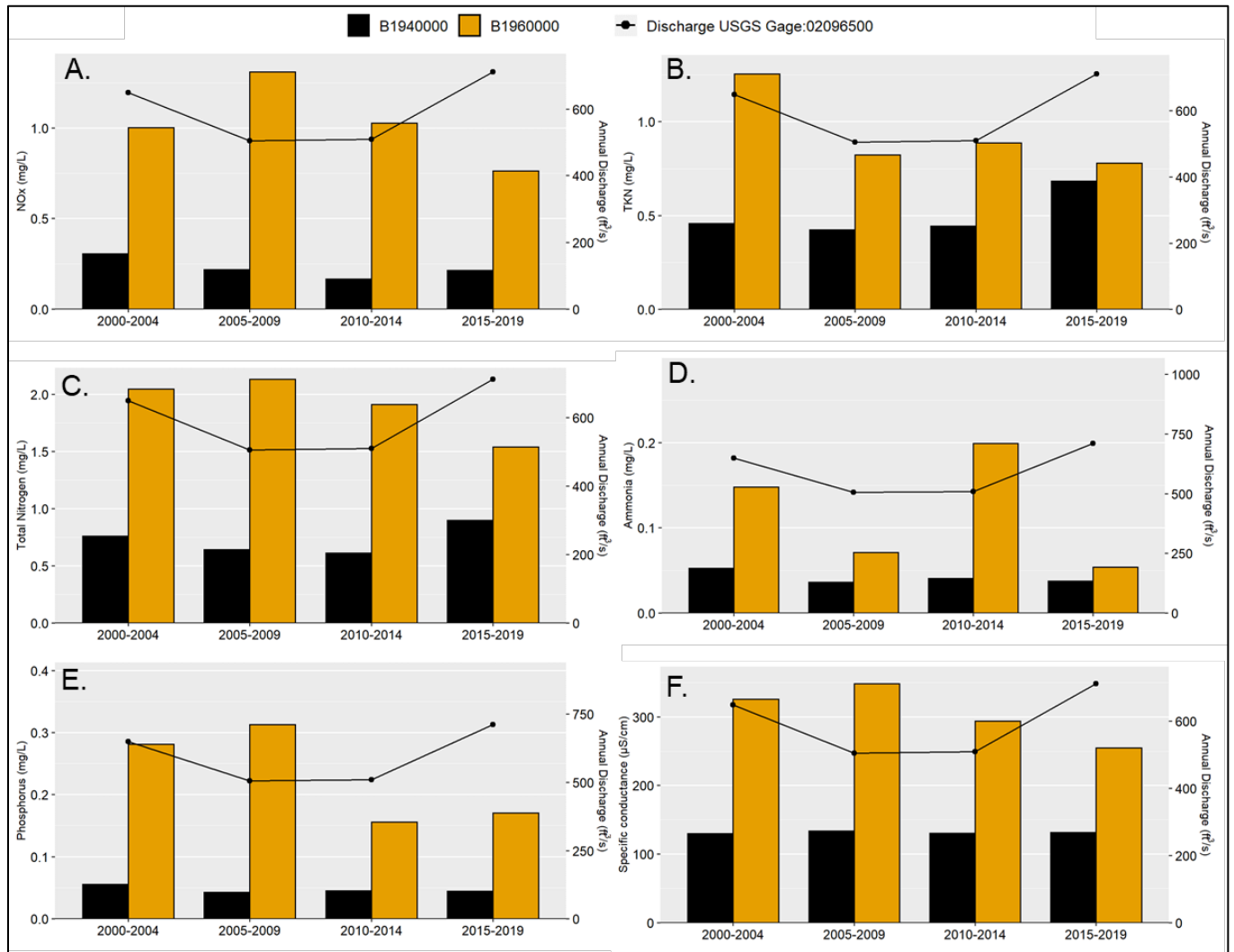
DWR Cape Fear River study, identified elevated levels of 1,4-dioxane in surface waters downstream of wastewater treatment plants (WWTPs) (see Chapter 13 for details). 1,4-Dioxane can enter a publicly owned treatment works as a constituent of industrial, commercial and domestic wastewater. Treatment plants are generally not designed to remove 1,4-dioxane; therefore, it can pass through treatment systems and enter surface waters from treated effluent discharge.

The City of Burlington signed a memorandum of agreement ([MOA](#)) with the Haw River Assembly on October 22, 2020, to formalize a commitment by the city to test, analyze, and examine potential sources of PFAS and 1,4-dioxane compounds discharged from the City’s two WWTPs (City of Burlington [website](#) and [Oct. 22, 2020 media information release](#)). According to the press release, the city also partnered with an engineering service to develop a wastewater sampling program aimed at identifying potential sources of these contaminants. The sampling plan included targeted and non-targeted sampling of the Burlington sewer system. Their comprehensive analysis included sampling the City’s industrial wastewater users (SIUs and landfill leachate brought to one WWTP), the City’s wastewater collection system, and their internal wastewater treatment plant processes. The goal was to identify potential sources and reduce or

eliminate these compounds prior to the WWTP discharge point. Their program could serve as a model for utilities across the state. See Chapter 13 for detailed information on 1,4-dioxane in the Cape Fear River basin.

*Implementation of Jordan Lake watershed rules will help improve the water quality in both Big Alamance Creek and Lake Mackintosh. There is a need to implement BMPs to reduce nutrients, fecal coliform bacteria, and turbidity loading. Fecal coliform levels are also elevated during dry weather, implying there is likely a need to address failing septic systems, illicit discharges, cows in the creek, and possibly leaky sewer systems.*

Figure 6-69: Big Alamance Creek 5-Year Mean Nutrients (N&P) and Specific Conductance Concentrations.



Station B1940000 is Located Upstream and B1960000 is Located Downstream of the 12 MGD Southside WWTP Discharge.

#### 6.6.3.5 *Big Alamance Creek Watershed Summary and Recommendations*

Best management practices to address nutrients, fecal coliform bacteria, turbidity/sedimentation and volume control are necessary to improve water quality throughout the Big Alamance Creek watershed.

The instream fecal coliform bacteria concentrations are high at the two ambient stations near the outlet of the Big Alamance subwatershed. This HUC-10 has the highest 2022 IR mean concentration of all the Haw River subbasin HUCs (1,056 cfu/100 mL) (*Table 6-10*). The northeast section of the watershed is densely developed but the remaining portions are very rural with a lot of agricultural lands (27%).

In 2014, a Little Alamance Creek Watershed (4b demonstration) Plan was developed to address the biological impairment in Alamance County, Little Alamance Creek as a result of the highly urbanized watershed. Stormwater runoff due to high levels of impervious surfaces and lack of stormwater treatment and control was identified as the main stressor in the watershed.

Lake Mackintosh is currently (2022 IR) classified as eutrophic so efforts should be taken in the watershed to reduce nutrient loading from the landscape to reduce the possibility of the lake becoming impaired. The county Soil and Water Conservation Districts should work with landowners to install voluntary measures to address sources of pollution to the water supply reservoir. Efforts should be made to monitor Lake Mackintosh at a frequency that will allow for a use support assessment.

Recommendations for this watershed include:

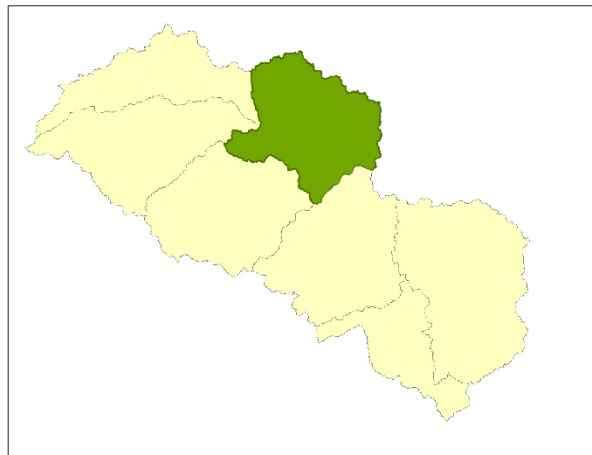
- Study to identify sources of bacteria throughout the watershed.
- Implementation of BMPs to address bacteria sources that occur in both wet and dry weather.
- Implementation of Little Alamance Creek 4b Demonstration Plan to address issues from highly impervious areas.
- Continue to monitor watershed for biological integrity, especially in areas where implementation measures have occurred.

In error, Rock Creek (AU# 16-19-8-3] from the source to Stinking Quarter Creek is listed on the 2022 IR as impaired for chlorophyll *a*. The station (CPFTR01) used to assess this stream is actually on Charles Turner Reservoir in the Rocky River subwatershed in the Deep River subbasin. Currently, there is no available data to assess Rock Creek. When resources allow, assess Rock Creek for biological integrity. Cedarrock Park is a possible sampling location.

#### 6.6.4 Back Creek – Haw River Watershed (0303000204)

Includes: Haw River, Back Creek, Moadams Creek, Jordan Creek, Travis Creek, Tickle Creek, Dry Creek, Town Branch & Stony Creek

Back Creek - Haw River Watershed HUC 0303000204 is essentially the eastern half of the old DWQ subbasin 03-06-02 watershed. The land cover is mostly forest (46%) followed by agriculture (28%) and developed lands (19%). There are 119 miles and 1,549 acres of water in this watershed are classified as HQW.



As of 2022, there were three major and eight minor NPDES wastewater facilities and three single-family NPDES permits with a combined as-built discharge of 18.05822 MGD (18.0575 for major and minor facilities and 720 gpd for single-family). The three major NPDES dischargers are the City of Burlington’s Eastside WWTP (NC0023868; 12.0 MGD), City of Graham WWTP (NC0021211; 3.5 MGD), and the City of Mebane WWTP (NC0021474; 2.5 MGD). Burlington Eastside and Graham WWTPs discharge to the Haw River, while the Mebane WWTP discharges to Moadams Creek which is a zero flow 7Q10 stream. There are also 35 NPDES and eight state stormwater facilities and 1,296 acres of non-discharge wastewater irrigation and residual solids land application fields in this watershed. Most of the fields are residual solids land application fields associated with the City of Durham (WQ0003504; 699 acres) and the City of Burlington (WQ0000520; 592 acres). There are also 23 very small wastewater irrigation fields, mostly less than a third of an acre, associated with single-family dwellings.

For this assessment (2002-2020), there are nine ambient stream monitoring stations (three AMS, six UCFRBA coalition), two RAMS sites, 14 benthic macroinvertebrate stations (including both basin and special study sites) and two fish community stations used to assess the water quality conditions over this time. Ambient ([Table 6-32](#)) and biology stations discussed in this section were used in the 2022 IR. A complete list of all 2002 to 2020 stations is located in the Chapter 2 Appendix.

The Haw River in this watershed flows from Ossipee to Swepsonville and receives drainage from two large drainage areas, Stony Creek and Back Creek, as well as from several smaller drainage areas on the southwest side of the river. The first upstream Haw River station in this subwatershed (B1020000) experiences a dramatic increase in nitrogen and phosphorus nutrient concentrations as well as increased conductivity and fecal coliform bacteria levels as compared to the nearest upstream station B0210000 (in HUC 0303000202) ([Table 6-32](#)). The 2016-2020, five-year mean concentration for TN jumped from 1.20 mg/L upstream at B0210000 to 2.91 mg/L at station B1020000, TP increased from 0.10 to 0.23 mg/L, the conductivity increased from 130 to 249  $\mu\text{S}/\text{cm}$ , and fecal coliform increased from 447 to 1,148 cfu/100 mL, respectively ([Table 6-27](#)). This dramatic increase in nutrients, conductivity, and bacteria is the result of the Reedy Fork watershed (0303000201) draining into the Haw River between these two stations which are about 9 miles apart. The high levels of instream nutrients and conductivity concentrations stayed relatively consistent at all the mainstem Haw River stations throughout this subwatershed ([Table 6-27](#)).

The current (2022 IR) impairment in this subwatershed includes biological integrity in four streams and chlorophyll *a* in several of the reservoirs due to excess biological productivity (*Table 6-33*).

*Table 6-32: Back Creek-Haw River (0303000204) Ambient Monitoring Stations Collected by DWR and the Upper Cape Fear River Basin Association Monitoring Coalition.*

Station ID	Station Location	Monitoring Program*	County	Stream AU#	Stream Classification + NSW	HUC 12
B0850000	HAW RIVER AT GERRINGER MILL RD NR OSSIPEE	UCFRBA	Alamance	16-(10.5)c	WS-V	30300020404
B1000000	DRY CREEK BESIDE SR 1530 NR BURLINGTON	RAMS	Alamance	16-13	WS-V	30300020404
B1020000	HAW RIVER AT SR 1700 HOPEDALE	UCFRBA	Alamance	16-(10.5)c	WS-V	30300020404
B1095000	JORDAN CREEK AT SR 1754 MR UNION RIDGE	AMS	Alamance	16-14-6-(0.5)	WS-II; HQW	30300020402
B1140000	HAW RIVER AT NC 49N AT HAW RIVER	AMS	Alamance	16-(10.5)d	WS-V	30300020408
B1200000	HAW RIVER AT NC 54 NR GRAHAM	UCFRBA	Alamance	16-(10.5)e	WS-V	30300020408
B1260000	TOWN BRANCH AT SR 2109 NR GRAHAM	AMS	Alamance	16-17	WS-V	30300020408
B1279000	UT TO STAGG CRK OFF NC 49 NR PLEASANT GROVE	RAMS	Alamance	16-18-2-(0.5)	WS-II; HQW	30300020405
B1350000	MOADAMS CREEK AT CORRIGDOR RD (UPSTREAM OF DISCHARGE NR MEBANE)	UCFRBA	Alamance	16-18-7	WS-V	030300020407
B1360000	MOADAMS CREEK AT SR 1940 GIBSON RD NR FLORENCE TOWN	UCFRBA	Alamance	16-18-7	WS-V	030300020407
B1440000	HAW RIVER AT SR 2158 SWEPSONVILLE RD NR SWEPSONVILLE	UCFRBA	Alamance	16-(10.5)e	WS-V	30300020408

Monitoring Program\*: AMS = DWR Ambient Monitoring System; UCFRBA = Upper Cape Fear River Basin Association; RAMS=Random Ambient Monitoring System.

Green highlighted denotes stations are no longer sampled.

Table 6-33: 2022 IR Water Quality Impairments by Stream Segment (AU#) for Back Creek-Haw River HUC 0303000204.

Stream	AU#	Classification	Description	Impairment Parameter (IR category)
Travis Creek	16-12	WS-V; NSW	From source to Haw River	Benthos (5)
Tickle Creek (Trickle Creek)	16-12-1	WS-V; NSW	From source to Travis Creek	Benthos (5)
Stony Creek (Lake Burlington)	16-14-(1)b	WS-II; HWQ; NSW	From Benton Branch to backwaters of Lake Burlington	Benthos (5)
Stony Creek (Stony Creek Reservoir)	16-14-(5.5)a	WS-II; HWQ; CA; NSW	From Buttermilk Creek to 0.4 miles upstream of dam	Chlorophyll <i>a</i> (5)
Jordan Creek	16-14-6-(0.5)	WS-II; HWQ; NSW	From source to a point 0.7 miles upstream of mouth	Benthos (5)
Back Creek (Graham-Mebane Reservoir)	16-18-(1.5)a1	WS-II; HWQ; CA; NSW	From 0.3 miles upstream of NC Hwy 119 to dam at SR1917	Chlorophyll <i>a</i> (4i) TN (4t) TP (4t)
	16-18-(1.5)a2a	WS-II; HWQ; CA; NSW	From 0.3 miles upstream of NC Hwy 119 to 0.3 miles upstream of dam	
	16-18-(1.5)a2b	WS-II; HWQ; CA; NSW	From 0.3 miles upstream of dam to dam	
	16-18-(1.5)b	WS-II; HWQ; CA; NSW	Quaker Creek Arm of Reservoir	Chlorophyll <i>a</i> (4i) TN (4t) TP (4t) Turbidity - 5
Town Branch	16-17	WS-V; NSW	From source to Haw River	Fecal Coliform Bacteria (4t)

#### 6.6.4.1 Travis and Tickle Creeks

Travis Creek [AU# 16-12; WS-V; NSW] from the source to Haw River and Tickle Creek [AU# 16-12-1; WS-V; NSW] from the source to Travis Creek was assessed in 2006 using benthic macroinvertebrate community structure and health and is currently impaired for aquatic life (2022 IR) due to fair ratings throughout the watershed (*Table 6-33*).

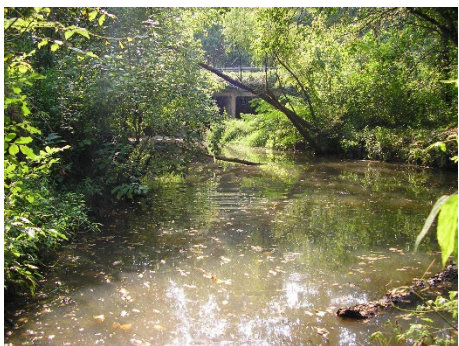
In 2005, the Division of Mitigation Services (DMS, formerly known as the NC Ecosystem Enhancement Program), selected Little Alamance, Tickle, Dry, Basin and Travis Creek watersheds for the development of a Local Watershed Plan (LWP) (2008 EEP Little Alamance, Travis & Tickle Creek Watershed Report & Project Atlas: Watershed Plan Phase III [report](#) and [Face Sheet](#)). As part of that planning effort, a special benthos survey was done on both Travis and Tickle creeks. *It is recommended that DWR biologist reassess this watershed during the next biological assessment if resources allow.*



accounted for the high habitat score. Visible land use at the site was 100% forest. The DO measured low at 4.5 mg/L while the conductivity was high at 165 µmhos/cm. The drainage area at this location was 3.8 square miles.



BI (6.44) of all the sites in the study. Total taxa richness was 66. Although less than one mile away from the Tickle Creek location, the substrate at Travis Creek at SR 1504 was much different. The four-meter-wide stream had a mostly sandy substrate. The majority of the 8.7 square mile watershed was covered in agriculture and forested areas, similar to that seen at the sampling location. The conductivity measured 153 µmhos/cm and the DO was 5.2 mg/L. The overall habitat score was 74.



Site BB034, Travis Creek at NC 87 was the most downstream site sampled in the Tickle/Travis Creek system and rated Fair. The EPT taxa richness was nine and the BI was 6.70. A total taxa richness of 70 was the highest found at any of the sites in the study. The most common and abundant taxa collected indicated that low flow, low DO and possibly nutrient enrichment played roles in affecting the benthic community at this site. This site was characterized by low flow, stagnant water and infrequent and small riffle areas which seemed to be prevalent in the study area during late summer. The substrate at this site was a good mixture of boulders, cobble, gravel and sand. The slightly turbid stream was seven meters wide. The DO was low at 3.9 mg/L and the conductivity measured 148 µmhos/cm. The habitat scored an overall 68 out of 100.

Benthic community site BB033 on Tickle Creek at SR 1504 rated Fair. The total taxa richness was 69, the EPT taxa richness was nine, and the BI score was 6.71. Common and abundant tolerant taxa suggest that low flow and low DO were stressors to the system. This site scored 82 out of 100 on the overall habitat, the highest score in the study. Flow was low, and riffles were infrequent at this site. The good mix of substrate, abundance of colonizable habitat, stable banks and vegetated riparian zones

<b>BB033 (Tickle Cr)*</b>	
<b>Year</b>	<b>Bioclassification</b>
2006	Fair
<b>BB003 (W UT Travis Cr)*</b>	
2006	Not Rated
<b>BB035 (Travis Cr)*</b>	
2006	Fair
<b>BB485 (E UT Travis Cr)*</b>	
2006	Not Rated
<b>BB034 (Travis Cr)*</b>	
2006	Fair
*Special Study	

6.6.4.2 *Stony Creek - Lake Burlington, Stony Creek Reservoir, Jordan Creek*

The Stony Creek watershed is classified as Water Supply II (WS-II), High Quality Water (HQW) and Nutrient Sensitive Waters (NSW). Land use is mainly forested and agricultural, and the watershed drains the southwest portion of Caswell County and a large portion of northern Alamance County. The reservoirs in this watershed serve as the City of Burlington’s water supply and are protected by specific regulations required in WS-II and HQW-classified waters (see [DWR surface water classifications](#)).

The headwaters of Stony Creek [AU# 16-14-(1)a] from the source to Benton Branch is identified as supporting for aquatic life as result of a 2018 Good fish (BF26) and a 2009 Good-Fair benthic macroinvertebrate (BB503) bioclassification at Stadler Road (SR 1104). However, about 0.3 miles downstream and below the confluence with Benton Branch, Stony Creek [AU# 16-14-(1)b; from Benton Branch to backwaters of Lake Burlington] benthic station BB231 located at Kerrs Chapel Rd (SR 1100) received a Fair bioclassification in 2013 and 2018, which is a decline from a Good rating in 1998.

<b>BB503</b>	
<b>Year</b>	<b>Bioclassification</b>
2003	Not Rated (drought)
2009	Good-Fair
<b>BF26</b>	
2003	Good-Fair
2009	Good
2013	Good
2018	Good
<b>BB231</b>	
2003	Not Rated (drought)
2013	Fair
2018	Fair

During the 1993 to 2003 time period, Stony Creek station BB503 was sampled at SR 1100. It was suggested that in 2009, the station be moved to SR 1104 because the riffle located at SR 1100 was atypical for this reach of the stream. The bioclassification at this station was Good from 1993 to 1998 then declined to Good-Fair in 2009. This part of the state experienced droughts in 2003 and 2008, thus the collection in 2003 was Not Rated. Although EPT richness in 2009 (23) was similar to those recorded in 1993 and 1998, whether the 2008 drought had any impact on Stony Creek is inconclusive.



At fish community site BF26, a diverse assemblage of fish was collected in 2018, with most of the same species present as in past assessments, but also included new individual records for black crappie (intermediately tolerant piscivore) and yellow bullhead (tolerant omnivore). As a result, the NCIBI score improved by 4 points due to the slightly higher total number of fish (n=286 in 2018 vs. 208 in 2013) and the additional sunfish species (black crappie). Species with young-of-year cohorts present in 2018 included redbreast sunfish (n=11), swallowtail shiner (n=4), speckled killifish (n=6), and margined madtom (n=1). With 24 fish species known from this location (but not including any pollution-intolerant taxa), species richness and trophic structure appears quite stable over several basin cycles. Overall, the fish assemblage continues to demonstrate Good water quality in this relatively small watershed.

Stony Creek at SR 1100 is located in southern Caswell County upstream of Burlington Reservoir (Lake Cammack). The watershed of Stony Creek is primarily forested with substantial amounts of agriculture and animal operations. Biological monitoring station BB231 on Stony Creek was sampled at SR 1104 in

2009 during the winter but moved back to the original basinwide station for 2013. A substantial drop in EPT taxa richness and the resulting increase in the EPT BI indicated a disturbance in the watershed had occurred. Measured macroinvertebrate habitat was good and physical-chemical water quality parameters were within normal ranges for an agricultural stream. Water clarity was turbid although excessive amounts of silt were not noted at the time of sampling. It is possible that the loss of taxa is acute rather than chronic and that recovery may be possible, but as of yet, the loss of macroinvertebrates remains unexplained. As this reach of Stony Creek has never rated less than Good-Fair prior to the 2013 sampling event it is recommended that another sampling occur to document the extent and duration of the biotic decline.

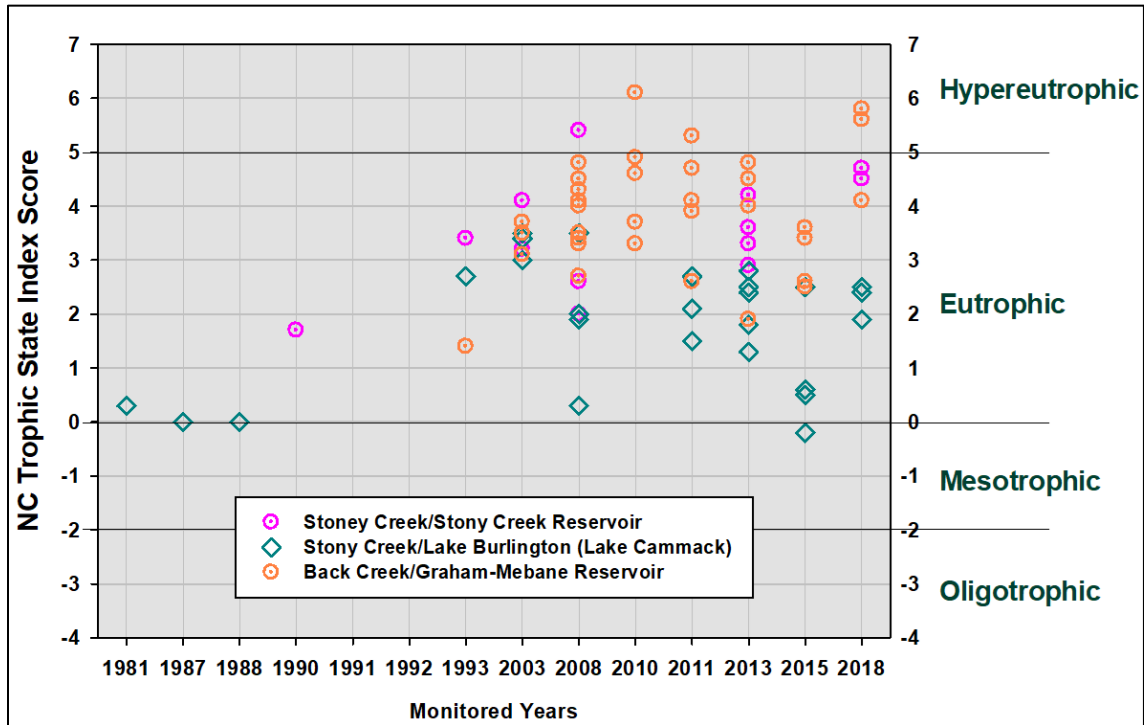
The DWR biologists indicated that the benthic community assessment metrics suggested *nonpoint source pollution as the likely cause of the impaired benthic community rating*. This section of Stony Creek [AU# 16-14-(1)b] has been listed as impaired since 2016 (IR) and remains on the 2022 list ([Table 6-33](#)).

Stony Creek/Lake Burlington [AU# 16-14-(1)c; Lake Burlington] (DWR ambient lakes monitoring program refers to this lake as Lake Cammack/Burlington Reservoir in their Lakes Report) was monitored monthly from May through August 2018 and found to exhibit elevated biological productivity with chlorophyll *a* concentration ranging between 18 and 29 µg/L. Lake Burlington has been classified as eutrophic since 1981 using the NC Trophic State Index ([Figure 6-70](#)).

Stony Creek/Stony Creek Reservoir [AU# 16-14-(5.5)a, from Buttermilk Creek to 0.4 miles upstream of the dam and AU# 16-14-(5.5)b, from 0.4 mile upstream of dam to the dam at Stony Creek Reservoir] (DWR ambient lakes monitoring program refers to this lake as Lake Burlington/Stony Creek Reservoir in their Lakes Report) was monitored monthly from May through August 2018 and found to exhibit elevated biological productivity with chlorophyll *a* concentration ranging between 24 and 60 µg/L. Half (50%) of the samples collected over the last two assessments periods (2013 and 2018) exceeded the state standard of 40 µg/L, resulting in the upper portion (lake station CPFSCR2) of the Stony Creek Reservoir being listed as impaired (AU# 16-14-(5.5)a)([Table 6-33](#)). The lower segment is listed as data inconclusive with only 25% of the samples (lake station CPFSCR4) exceeding the chlorophyll *a* standard. Stony Creek Reservoir has been classified as eutrophic since 1990 ([Figure 6-70](#)). Stony Creek Reservoir is the City of Burlington's drinking water reservoir. The watershed draining to Stony Creek Reservoir also includes Jordan Creek, Buttermilk Creek, Deep Creek and Mine Creek watersheds. There is only a single minor wastewater discharger in the headwaters of Laughin Creek which flows into Buttermilk Creek: NC0001384- Burlington Technologies with an as-built flow of 25,000 GPD. There are several residual land application fields in the watershed and the [SWAP report](#) gives the reservoir a moderate susceptibility rating. The Sources Water Assessment Program (SWAP) report indicates a water supply's potential to become contaminated according to the possible contaminant sources identified within the assessment area.)

*As implementation of Jordan Lake NSW rules occur throughout this watershed, water quality conditions in the reservoirs and feeder streams should improve as nutrient contributions from all sources decline.*

Figure 6-70: Back Creek- Haw River Watershed (0303000204) Lake Trophic Status (NCTSI).



Yearly Average (1980's and 1990's) or Monthly Lake NCTSI Average (2000 to present) are Presented (Data from WSS/ISB Lakes Program, January 2020).

Jordan Creek [AU # 16-14-6-(0.5)] from source to a point 0.7 miles upstream of the confluence with Stony Creek Reservoir, drains to the impaired portion of Stony Creek Reservoir. Jordan Creek is assessed for aquatic life using ambient water quality conditions at ear River Basin (McCray Rd.) as well as for biological community health. Based on the 2019 (NLCD) land use, the 24 square miles rural watershed at station B1095000, is 32% agriculture and 52% forested. Jordan Creek is a water supply-II (WS-II), High Quality Water (HQW), NSW watershed. The current conditions suggest that this water supply, HQW watershed is stressed and in need of restoration efforts to improve and protect this important resource.

Jordan Creek is listed as Impaired (2022 IR) due to a Fair benthic macroinvertebrate bioclassification rating at station BB214 (July 2013) (Table 6-33). The biologists noted that the water quality parameters for Jordan Creek were within normal ranges for agricultural streams and did not indicate any glaring problems. However, instream macroinvertebrate habitat was highly deficient with a significant amount of sand in the channel and high bank erosion rates and appears to be worsening. Taxa typically found in flowing water, such as heptageniid mayflies, were absent from the



2009 sample, suggesting the stream still has lingering impacts from the 2008 drought. Because of the low number of EPT taxa and the absence of flow dwelling species, Jordan Creek was Not Rated in 2009. Previously, the station had consistently received Good-Fair ratings. EPT taxa richness continued to decline, with a record low of nine taxa in 2013. Caddisflies were all but absent in 2013, stoneflies entirely absent, and sensitive mayflies disappeared from recent samples. The resultant BI indicates a tolerant community is now present in the stream. This stream was rated Fair for the first time in 2013 (BB214).

BB214	
Year	Bioclassification
2009	Not Rated
2013	Fair
BF46	
2009	Good
2013	Good-Fair
2018	Good-Fair

In 2018 at fish community station BF46, there was a moderate to lower diversity fish community with similar abundances as previous samples but including two new minnow taxa [bluehead chub (intermediately tolerant omnivore) and creek chub (tolerant insectivore)]. The fish community here continued to exhibit lower species richness (total of 17 known species from this location, all intermediately tolerant or tolerant species) and abundance (range of 60-88 fish present in the 4 DWR assessments conducted here) for a stream of this size. Physiographic isolation of this watershed (positioned between Lake Cammack and Stony Creek Reservoir) likely continued to inhibit recruitment opportunities of certain species during low-flow years. However, the site maintained its Good-Fair rating over 15 years, with seemingly stable water quality.

The ambient water quality data reflected the impacts noted by the biologists with elevated turbidity levels at station B1095000 (SR 1754/McCray Rd.; co-located with BF46) (*Table 6-34*). Since 2011, the number of yearly excursions of the turbidity standard (50 NTU) ranged between 8.3% and 27.3% of the samples collected (with 6 of the last 9 years > 10%; *Figure 6-71*) (figure will be updated). For the 2022 IR assessment period (2016-2020), the mean turbidity concentration was 20.9 NTU and the monthly readings exceeded the standard 14% of the time which resulted in a data inconclusive rating for turbidity.

Jordan Creek drains to Stony Creek Reservoir and likely contributed to the elevated turbidity levels and low Secchi depths observed during the 2018 monitoring period. Sediments can also carry nutrients like phosphorus which contributed to the eutrophication and impairment in the reservoir. Currently (2022), nutrients are not monitored at station B1095000. *It is recommended, when resources allow, to add nutrient monitoring in Jordan Creek to help understand the overall nutrient impacts coming from this watershed to Stony Creek Reservoir.* A short-term special monitoring study would be helpful to determine if collecting nutrient data from this watershed over a long term would be beneficial to DWR. There is an obvious need to reduce nutrient loading to Stony Creek reservoir. Having nutrient data would also allow DWR to capture any nutrient reduction that will occur in response to the Jordan Lake NSW rule development and implementation that will take place throughout the entire Haw River watershed.

Table 6-34: Jordan Creek, Town Branch and Moadams Creek Watershed (0303000204) Five-Year Instream Mean Concentration at Ambient Stations (2016-2020) with Seasonal/Nonseasonal Mann-Kendall Trends (Calculated at 95% Confidence).

Watershed Information	Station	TN# (mg/L)	NOx (mg/L)	TKN (mg/L)	NH3 (mg/L)	TP (mg/L)	Fecal C. (cfu/100 mL)	Turbidity (NTU)	Conductivity (µS/cm)	Station Trend* Information 2000-2019 & 2010-2019 Decreasing (↓) or Increasing (↑) Seasonal (S) or Non-Seasonal (NS)	HUC 10 0303000_ & Stream Class
Jordan Creek Rural watershed	B1095000	NA	NA	NA	NA	NA	633	20.9	98	Fecal C. - ↑ S 00-19; Conductivity - ↓ S 00-19	204 WS-II; HQW; NSW
Town Branch Urban watershed	B1260000	0.85	0.42	0.43	0.03	0.06	748	14.9	275	TP - ↓ S 00-19; Turbidity - ↓ S 00-19; Conductivity - ↑ S 00-19	204 WS-V; NSW
Moadams Creek Upstream of Major WWTP Urban watershed	B1350000	1.16	0.61	0.55	0.04	0.03	1116	17.8	157	TSS - ↑ S 00-19; Conductivity - ↑ NS 10-19;	204 WS-V; NSW
Moadams Creek Downstream of Major WWTP Urban watershed	B1380000	2.26	1.17	1.08	0.22	0.31	581	13.0	421	TP - ↓ S 00-19 & 10-19; NOx - ↓ S 10-19; Fecal C. - ↓ S 00-19; Turbidity - ↓ S 00-19; Conductivity - ↑ S 00-19	204 WS-V; NSW

# TN is calculated as NOx + TKN. Both values were required to develop a TN value.

\* DWR conducted a seasonal or nonseasonal Mann-Kendall trend test at most AMS stations that had sufficient data available; reporting only significant increasing or decreasing trends, calculated at 95% confidence from data collected from 2000-2019 and 2010-2019.

For Non-detects or records below the detection limit, the detect limit value is used in the overall summary means and half the detection limit for trends analysis.

NA – no data is available for that specific parameter during the assessment period.

Fecal coliform bacteria levels were also elevated in Jordan Creek as demonstrated by the 2022 IR five-year (2016-2020) mean of 633 cfu/100mL, geometric mean of 296 cfu/100 mL and 30.7% of the samples greater than the 400 cfu/100 mL standard (Table 6-34). A seasonal Mann-Kendall trend analysis found a significant increasing trend (calculated at 95% confidence) in fecal coliform bacteria for samples collected between 2000 and 2019 (Table 6-34 and Figure 6-72). A 5-in-30 bacterial assessment was not completed in this watershed; therefore, Jordan Creek is currently (2022 IR) listed as data inconclusive (category 3a). The category 3a listing recognizes that the concentrations were elevated above the current instream standard, but an additional assessment is required to confirm the state standard is not being met (a 5-in-30 is a requirement of the standard assessment method).

Stony Creek watershed drains into the Haw River [AU# 16-(10.5)c] which has a turbidity and fecal coliform bacteria TMDL as well as part of the Jordan Lake nutrient TMDL. Implementation measures needed to meet the load reductions necessary for this segment of the Haw River and Jordan Lake must be applied to the Stony Creek watershed. These same implementation measures would help improve the water quality throughout the Stony Creek watershed. It is recommended that the county Soil and Water Conservation Districts work with willing landowners to implement BMPs to reduce the flashiness, turbidity, and fecal coliform from entering the stream system throughout the Stony Creek watershed.

Figure 6-71: Jordan Creek Station B1095000 Annual Mean Turbidity Concentrations (2000-2019).

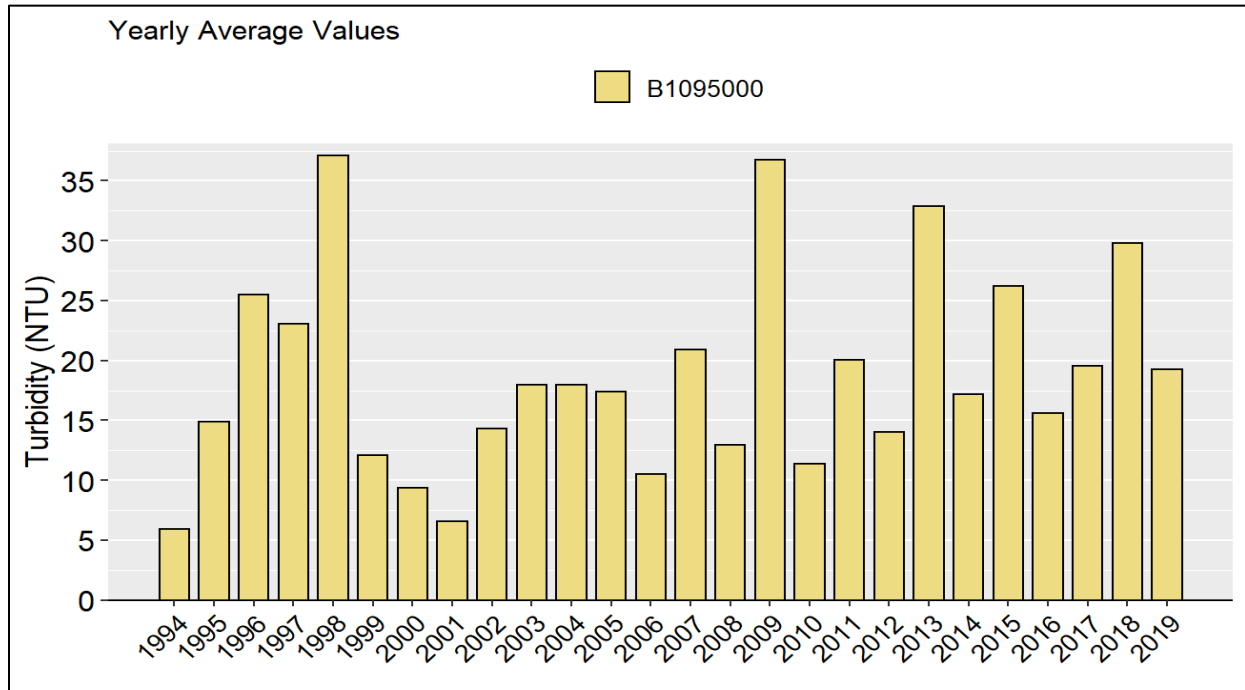
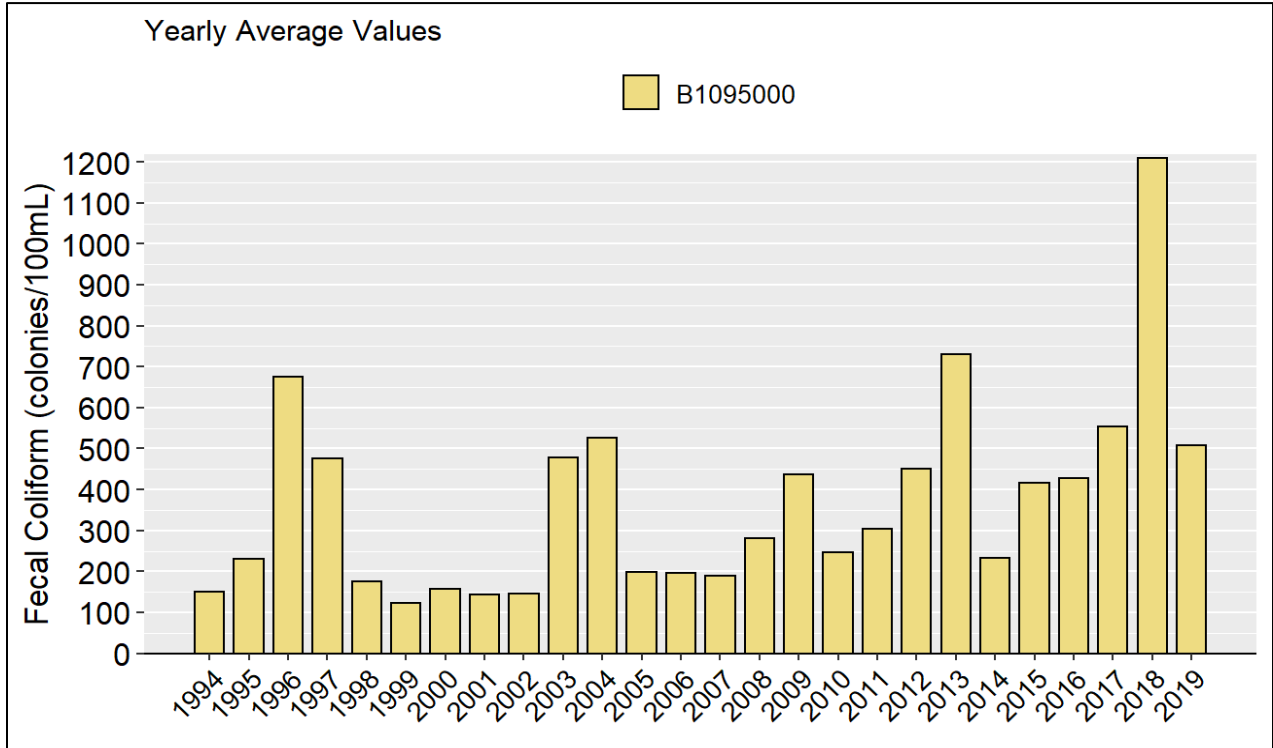


Figure 6-72: Jordan Creek Station B1095000 Annual Mean Fecal Coliform Bacteria Concentration.



#### 6.6.4.3 Town Branch

Town Branch [AU# 16-17] from the source to the Haw River captures runoff from an approximately four-square miles watershed that flows through the town of Graham and is about 82% developed with an impervious cover of 28.8%, based in 2019 NLCD dataset at AMS station B1260000 located near the confluence with the Haw River. Town Branch has a 2002 EPA approved fecal coliform bacteria TMDL, which determined the need for a 70% load reduction to meet water quality targets. The source of bacteria to Town Branch was identified as nonpoint source urban stormwater runoff and possibly leaky sanitary sewer lines. At the time of the TMDL development there was a single unsewered neighborhood that could also contribute to the nonpoint source load. The fecal TMDL suggested that implementation efforts must include reduced loading from urban runoff, as well as address SSOs through infrastructure maintenance and repairs. It was also recommended that the town connect the septic/unsewered neighborhood to their municipal wastewater treatment facility to eliminate the source from older, less efficient and failing septic systems. In 2003, 319 funding was awarded to Piedmont Triad Regional Council (PTRC) to start implementation in this watershed (PTCOG). The DWR basin planner will work with PTRCOG and the town of Graham to update implementation efforts in this watershed.

Fecal coliform bacteria levels remained elevated as demonstrated by the annual mean concentration and percent of readings greater than 400 cfu/100 mL as well as by the 2022 IR five-year data summary statistics (748 cfu/100 mL mean, 307 cfu/100 mL geometric mean and 43.8% of the samples greater than the 400 cfu/100 mL standard) (*Table 6-34* and *Figure 6-73*). A seasonal Mann-Kendall trend analysis did not find a significant change in fecal coliform bacteria concentrations between 2000 and 2019. Additional implementation measures are needed in this watershed to address the fecal coliform bacteria impairment.

The instream turbidity concentrations in Town Creek are also elevated (*Table 6-34* and *Figure 6-74*). Many of the urban BMPs used to reduce stormwater runoff to prevent fecal coliform bacteria from entering the stream also prevent sediment from entering streams and decrease peak flow volumes. Lower peak flows in turn lessen bank erosion and further reduce instream sedimentation.

Recommendations for Town Branch watershed include implementation of urban stormwater control measures to prevent fecal bacteria, sediment and nutrients from entering Town Branch and to address any collection system issues throughout the watershed to reduce bacteria and nutrient from entering surface waters.

Figure 6-73: Town Branch Station B1260000 Annual Mean Fecal Coliform Bacteria Concentration.

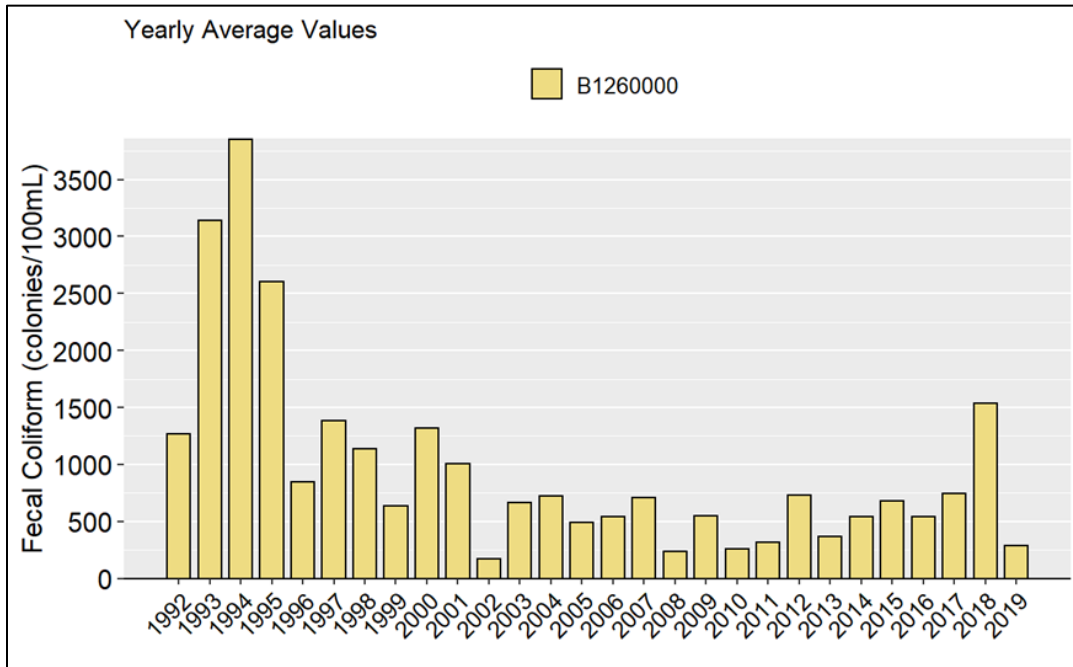
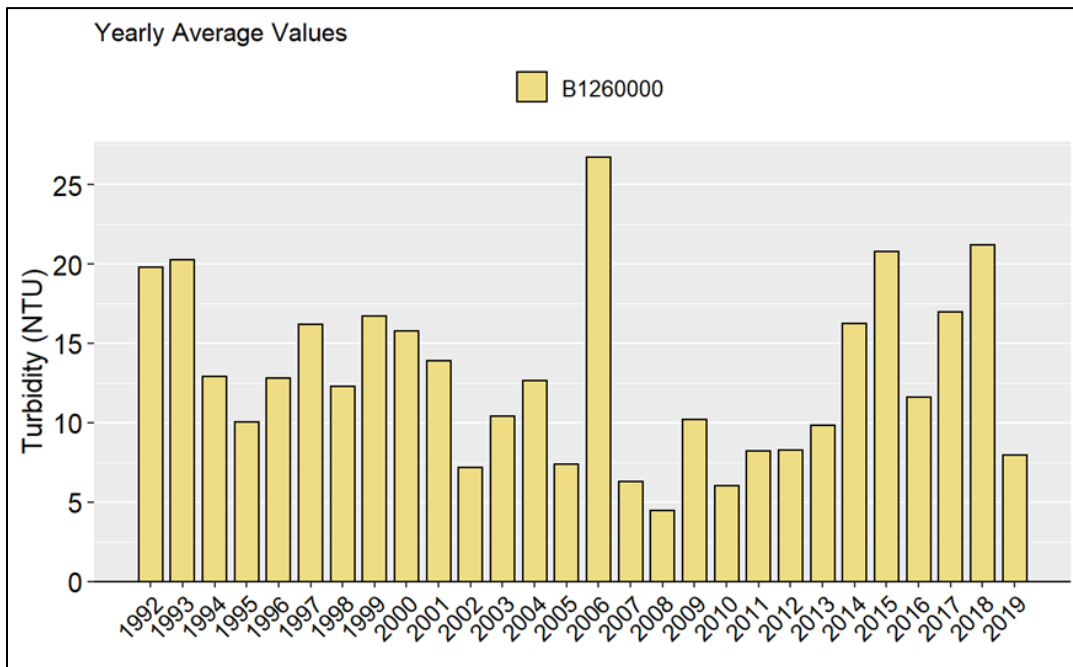


Figure 6-74: Town Branch Station B1260000 Annual Mean Turbidity.



#### 6.6.4.4 Back Creek, Graham-Mebane Reservoir, Moadams Creek

Back Creek/Graham-Mebane Reservoir [AU #'s 16-18-(1.5)a1, 16-18-(1.5)a2a, 16-18-(1.5)a2b, and 16-18-(1.5)b; WS-II, HQW, NSW, CA] from a point 0.3 miles upstream of NC Hwy 119 to the dam at Graham-Mebane Reservoir is a water supply source for the towns of Graham, Mebane, Green Level and Haw River. The reservoir was most recently monitored monthly from May through August 2018 and found to exhibit elevated biological productivity with chlorophyll *a* concentration ranging from 29 to 78 µg/L. Sixty-five percent (65%) of the samples collected at all 5 stations exceeded the state standard of 40 µg/L, resulting in the entire lake being listed as impaired (2022 IR; chlorophyll *a* – category 4i) (*Table 6-33*). In 2018, the reservoir was classified as eutrophic (June and August) and hypereutrophic (May and July) based on the calculated NCTSI score (*Figure 6-70*). Graham-Mebane Reservoir had been monitored during eight summer growing seasons since 1993 and was identified as extremely productive (hypereutrophic) during part of each growing season in 2010, 2011 and 2018 (*Figure 6-70*). There is an EPA approved TMDL ([September 2010](#)) for Back Creek/Graham-Mebane Reservoir. The impaired reservoir is subject to the associated nutrient reductions of 8% TN and 5% TP required by the [2007 Jordan Lake](#) Haw River arm TMDL. It is important to implement these reductions in order to see improvements in the water quality of this drinking water reservoir.

Benthic community site BB518, on an unnamed tributary of Stagg Creek, was sampled as part of a special study in 2010 and was not rated as it was sampled outside of the small streams seasonal sampling window (April-June). However, the biotic index is consistent with a Good-Fair bioclassification using the small streams biocriteria for piedmont streams. The invertebrate community present at the site was generally depauperate in richness. The elevated biotic index and low EPT richness suggest a moderately pollution tolerant community, which is also consistent with the 108 µS/cm conductivity value measured on the day of sampling.

The Quaker Creek arm of Graham-Mebane Reservoir [AU# 16-18-(1.5)b] has also remained impaired for turbidity since 2008 (*Table 6-33*). In 2018, the turbidity concentrations ranged between 22 and 35 NTU with three of the four records (75%) exceeding the lake standard of 25 NTU (lake station CPGMROA/CPFGMR01). Turbidity was elevated throughout most of the lake in 2018. *BMPs to reduce sediment loading to the reservoir and reduce peak flows to the receiving streams are recommended;* these include, Otter, Scrub, Quarter, Stagg, Back and Mill creeks.

Moadams Creek [AU# 16-18-7; WS-V, NSW] from the source to Back Creek has its headwaters in the town of Mebane and flows into Back Creek about 1.2 miles downstream of the Graham-Mebane Reservoir dam. There are two ambient monitoring stations, one upstream (B1350000; at Corregidor St.) and one downstream (B1380000; at Gibson Rd.) of the 2.5 MGD Mebane WWTP (NC0021474). The watershed is approximately 64% developed with an estimated impervious cover of 18.8% at downstream station B1380000 (2019 NLCD). Both stations are monitored by the Upper Cape Fear River Basin Association monitoring coalition program, so they are generally monitored within a short time period of each other (*Table 6-32*). Moadams Creek is a zero 7Q10 stream, which is a hydrologically based flow estimate indicating the lowest seven-day average flow that occurs (on average) once every 10 years. A zero 7Q10 means that 100% of the stream flow during these low-flow events are wastewater effluent. The Mebane WWTP performs whole effluent toxicity (WET) tests to ensure that the instream aquatic communities are

protected from toxicity even in low flow conditions. The data at the ambient stations showed significantly higher instream nutrient concentrations (TN, NO<sub>x</sub>, TKN, NH<sub>3</sub>, TP) and conductivity/specific conductance levels at the downstream station (B1380000) which is indicative of impacts from a large WWTP discharge to a small stream (*Figure 6-75 A-F*). There was a decline in NO<sub>x</sub> and TN (due to the reduction in NO<sub>x</sub>). The instream NO<sub>x</sub> concentration dropped dramatically from the 2010 annual mean concentration of 4.94 mg/L to 1.17 mg/L in 2019 (*Figure 6-76*). The upstream concentration at B1350000 remained below 1.0 mg/L for all years assessed [*Figure 6-76*; 2004 (n=2) and 2011-2019 (n= 11 or 12 each year)]. DWR conducted a seasonal Mann-Kendall trend test for individual nutrients at station B1380000 (downstream station) and found a significant decreasing trend in NO<sub>x</sub> and TP (calculated at 95% confidence) from data collected between 2010-2019 (TN was not included in the trends assessment; *Table 6-34*).

Water Quality Parameter	B1380000 2010 Mean Concentration	B1380000 2019 Mean Concentration	Change
TN	5.81 mg/L	2.11 mg/L	Decreased
NO <sub>x</sub>	4.94 mg/L	1.17 mg/L	Decreased*
TKN	0.86 mg/L	0.94 mg/L	Increased
NH <sub>3</sub>	0.19 mg/L	0.12 mg/L	Decreased
TP	0.40 mg/L	0.25 mg/L	Decreased*
Conductivity	331 μs/cm @25°C	452 μs/cm @25°C	Increased

\*A significant decrease in instream NO<sub>x</sub> and TP concentration between 2010 and 2019 was identified using a seasonal Mann-Kendall trend analysis (at 95% confidence level).

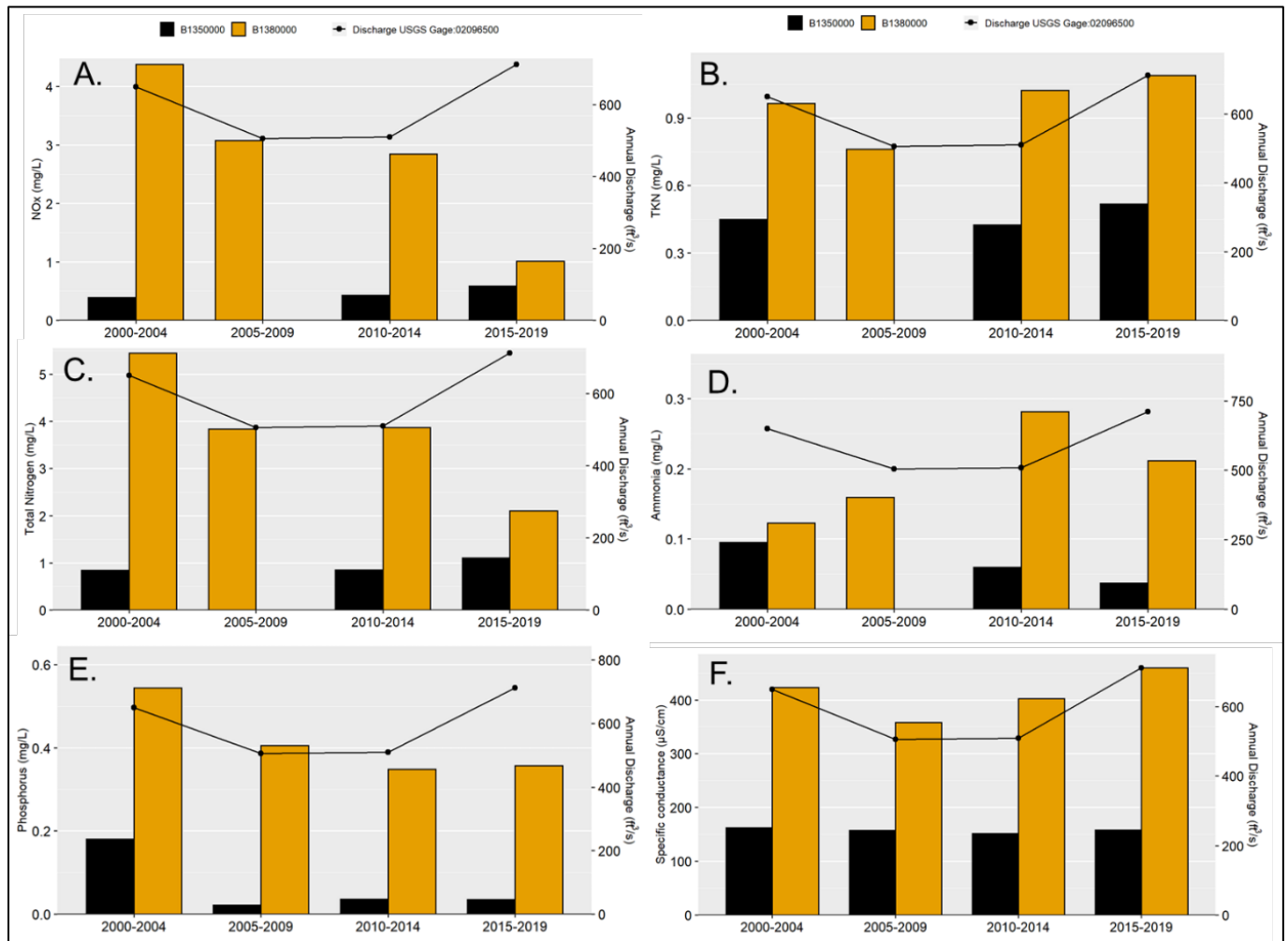
The City of Mebane’s 2014 NPDES permit (NC0021474) renewal required a nitrogen optimization plan be developed to implement measures and to continually evaluate their treatment facility and operational processes to make reasonable efforts to reduce nitrogen discharges until process improvements were completed. Mebane had until January 2019 to comply with their annual TN mass loading limit of 40,225 lbs/yr (end of pipe). Their optimization measures were very successful and reduced their TN loading as can be seen by the change in the instream concentrations over the years (*Figure 6-76*). The City of Mebane’s 2.5 MGD wastewater permit was renewed in October 2023 with an expanded flow tier of 4.0 and 6.0 MGD ([October 2023 permit](#)). Their average discharge rate between April 2018 and September 2022 was 1.6 MGD with an average TN and TP concentration of 4.8 and 0.8 mg/L (draft 2023 NPDES permit fact sheet). There have been elevated instream ammonia concentrations in Moadams Creek with a 2022 IR period instream average of 0.22 mg/L at the downstream station B1380000 (*Table 6-34* and *Figure 6-75*). The elevated ammonia concentration is likely due to the fact that a large portion of the stream flow is from the wastewater treatment plan. The current Mebane WWTP ammonia limits are 2.0 and 4.0 mg/L, monthly average summer (April-October) and winter (November-March) concentrations respectively. These concentrations will likely be lowered as they expand to 4.0 and 6.0 MGD.

Table 6-35 Mebane WWTP Annual Total Nitrogen and Total Phosphorus Jordan Lake Allocation and their Yearly Load between 2018 and 2022.

Mebane WWTP NC0021474	Allocation lbs/yr	Delivery Factor	2018 lbs/yr	2019 lbs/yr	2020 lbs/yr	2021 lbs/yr	2022 lbs/yr
<b>Total Nitrogen</b>	40,225	56%	27,347	19,682	32,981	21,590	21,802
<b>Total Phosphorus</b>	5,056	55%	3,665	4,280	3,031	4,765	4,362

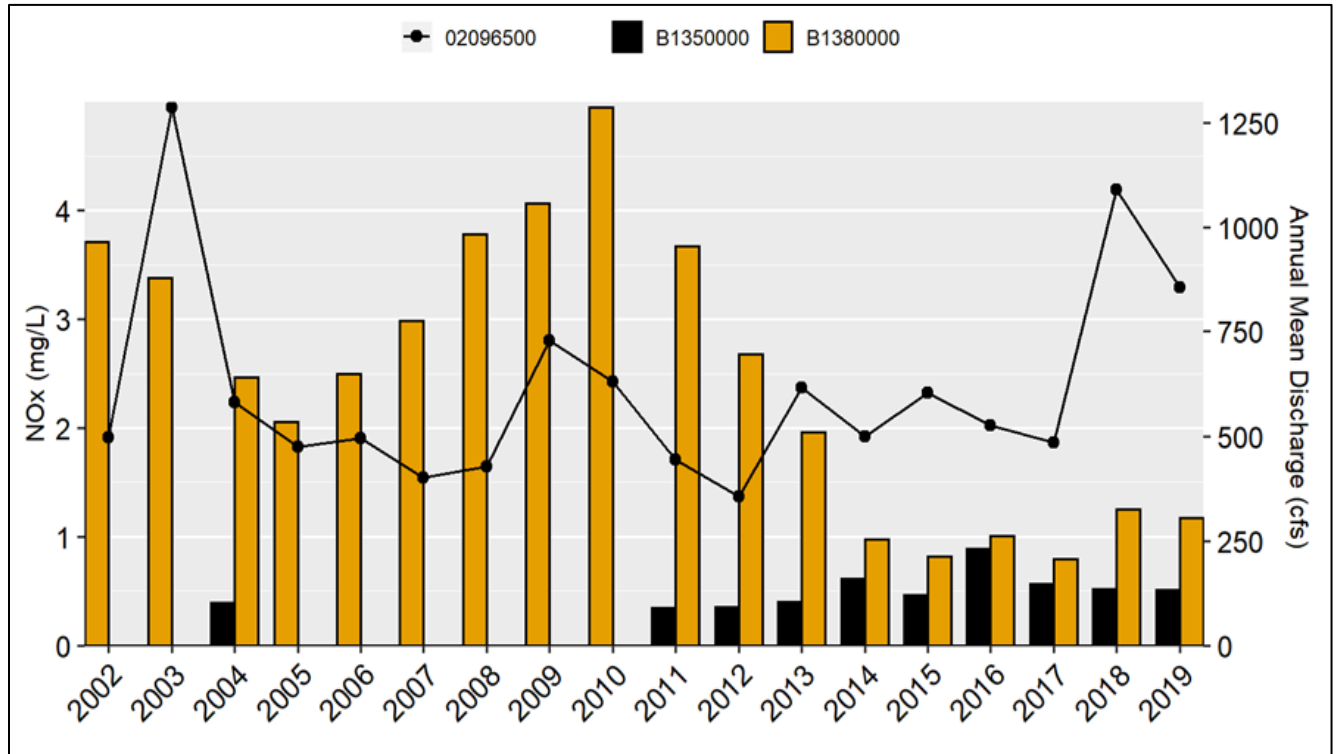
Jordan Lake nutrient strategy (15A NCAC 02B .0262)

Figure 6-75: Moadams Creek Five-Year Average Concentrations at Stations B1350000 (upstream of WWTP; Black Bar) and B1380000 (downstream of WWTP; Orange Bar) with Stream Flow at Haw River at Haw River USGS Gage Station 02096500.



Note: Data for B1350000 is limited prior to 2011; for nitrogen related parameters each year, n=2 in 2004 and n= 11 or 12 in 2011-2019; for phosphorus n=1 to 3 between 2004-2007 and n= 11 or 12 in 2011-2019; for conductivity n=14 to 19 for each year. Data for B1380000, n=7 to 19 records each year.

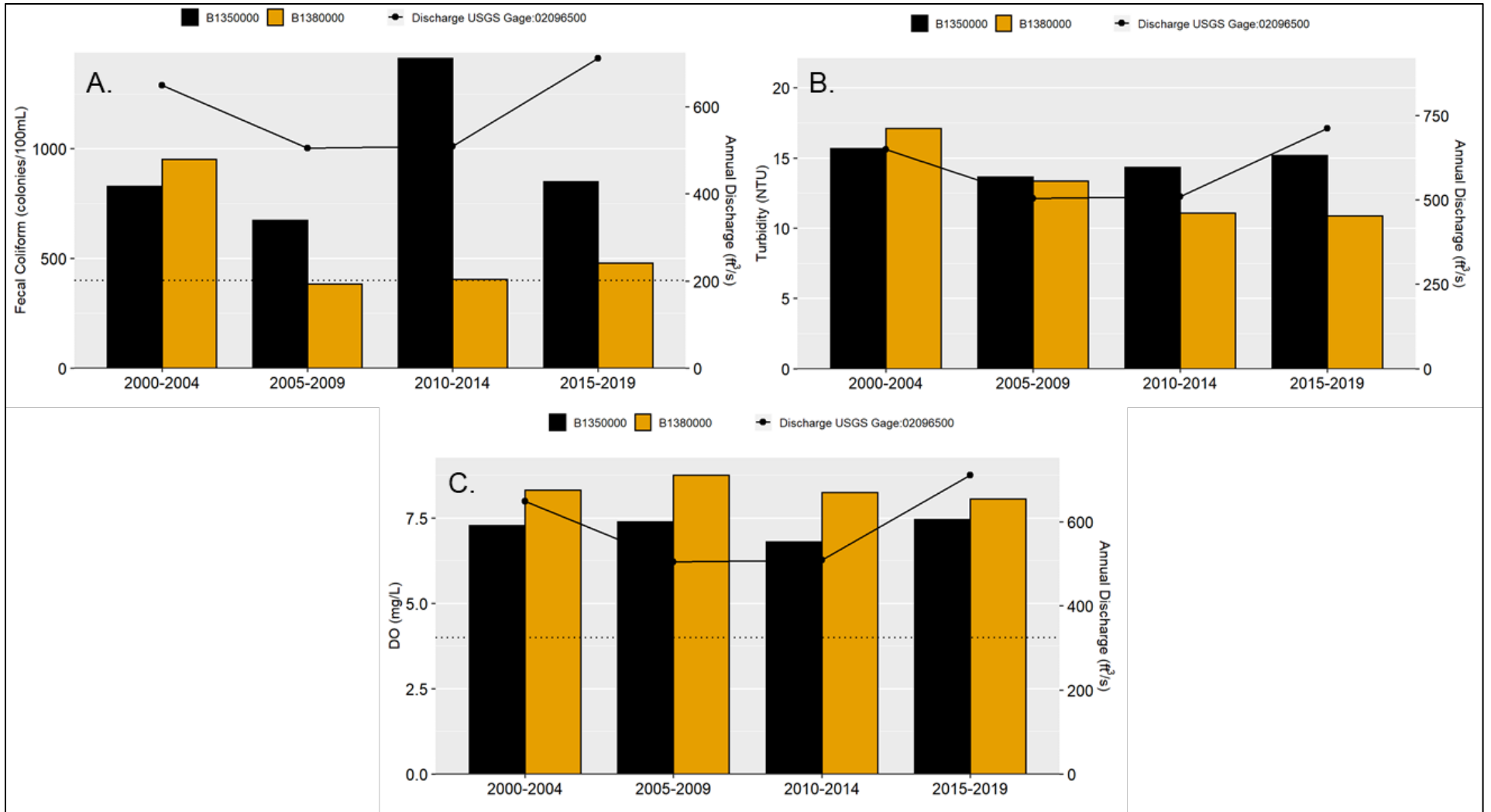
Figure 6-76: Moadams Creek Yearly NOx Average Concentrations at Stations B1350000 (upstream of WWTP) and B1380000 (downstream of WWTP) with Stream Flow at Haw River at Haw River USGS Gage Station 02096500 (n=2 for B1350000 in 2004)



The Mebane WWTP has been in compliance with both their TN and TP mass load limits since 2010. The highest yearly TN load to date was in 2020 with a mass load of 32,981 pounds, which is about 82% of their allocated load (Table 6-35). The City of Mebane is also a member of the Haw River Nutrient Compliance Association (NCC000003). Mebane identified the presence of 1,4-dioxane in their influent during a 2019 investigation for emerging compounds in the Cape Fear River Basin. Monthly influent and instream monitoring downstream in the Haw River at Old Greensboro Road and Old Bynum Bridge has been added to the permit. A special condition to monitor wastewater effluent for PFAS chemicals quarterly was also added to the permit, effective six months after EPA has a final wastewater method in 40 CFR 136 method published in the Federal Register.

Moadams Creek often has elevated concentrations of fecal coliform bacteria and turbidity as result of stormwater runoff. Since about 2005, the instream concentrations are generally lower at the downstream station (B1380000), likely due to the added flow to the stream from the wastewater treatment plant effluent (2.5 MGD), diluting the instream concentration (Figure 6-77 A & B). The mean dissolved oxygen (DO) levels are subsequently higher downstream as a result of the added flow in the stream as well (Figure 6-77 C).

Figure 6-77: Moadams Creek Five-Year Average Concentrations at Stations B1350000 (upstream of WWTP; Black Bar) and B1380000 (downstream of WWTP; Orange Bar) with Stream Flow at Haw River at Haw River USGS Gage Station 02096500.



#### 6.6.4.5 Haw River Mainstem

Haw River [AU #'s 16-(10.5)c, 16-(10.5)d, and Back Creek watershed portion of 16-(10.5)e; WS-V, NSW] from the confluence with Reedy Fork to confluence with Big Alamance Creek near Swepsonville is an approximately 18 mile stretch of river that flows through or near several towns, including Glencoe, Hopedale, Burlington, Graham, Haw River and Swepsonville. There are four AMS stations and one benthic macroinvertebrate station currently used to assess this segment of the Haw River mainstem (*Table 6-36*). There are two major and two minor WWTPs that discharge directly to this segment of the Haw River mainstem. AMS station B1020000 captures the influence from the upstream headwater Haw River segments, the highly impacted Reedy Fork watershed, Travis Creek and the two minor WWTP dischargers. Station B1140000, about 3.5 miles downstream, captures the Stony Creek watershed drainage as well as Service Creek, which flows through parts of Morgantown and Burlington, and the discharge from the City of Burlington's Eastside WWTP (12 MGD; NC0023868). This station is also co-located with the USGS gage station at Haw River, NC (02096500) and will be used to understand the impacts of flow on the water quality. The next station, B120000 is only about 3.1 miles downstream and is a well buffered segment of the Haw River that flows under Interstate Hwy 40 near Alamance Community College. Station B144000 near the bottom of this HUC 10 watershed is 1.75 miles downstream and captures flow from Town Branch and Back Creek watershed and the discharge from the City of Graham's WWTP (3.5 MGD; NC0021211) (*Figure 6-4, Figure 6-12, and Figure 6-16*).

*Table 6-36: Back Creek-Haw River HUC 0303000204 Mainstem Haw River Assessment Units Information and Water Quality Assessment Stations and 2022 IR Categories (subset of Table 6-24).*

Haw River AU	~Stream Length (Miles)	Description	AMS	Benthic Station	2022 IR Categories (3, 4,& 5) and Associate Parameter of Interest	Discharge to AU
16-(10.5)c	10.1	From Reedy Fork to Service Creek	B1020000	BB002 – Not Rated	3a- Turbidity 3a – Fecal CB	2 minors = 26,500 gpd Western Alamance MS & HS
16-(10.5)d	2.1	From Service Cr. to NC 49 (Haw R. at Haw River)	B1140000 Co-located USGS Gage 02096500		3i – Turbidity 3t- Total Suspended Solids 4t – Fecal CB	1 Major = 12 MGD Burlington – Eastside WWTP
HUC 10 portion only 16-(10.5)e*	5.5	From NC 49 to Big Alamance Cr.	B1200000 B1440000	BB022 – Good	3a- Turbidity 3a – Fecal CB	1 Major = 3.5 MGD Graham WWTP

\*The full length of the Haw River AU# [16-(10.5)e] is an 18.5 miles stretch from NC 49 to a point 0.4 miles downstream of Cane Creek (South Side of Haw River) in HUC 0303000205 Cane Creek-Haw River.

A 2005 TMDL for the Haw River from NC 87 (in the upper headwater Haw River HUC 0303000202) to NC 49 was approved by the EPA for turbidity and fecal coliform bacteria ([2005 Haw TMDL](#)). The ambient monitoring station used to develop the TMDL was B1140000 at NC 49. A six-week special study in 2004, found that storm events carried a substantial amount of sediment and solid materials from urban as well as agricultural lands. A significant relationship between turbidity and flow was observed in the Haw River, where urban lands are rapidly expanding (NCDENR, 2005). There was high TSS loading during high and

transitional flows (top 30<sup>th</sup> percentile flows) suggesting that the source of turbidity could be from stormwater runoff and stream bank erosion. Because of the soil type in the Haw River watershed, bank erosion often causes high flocculation of clay and silt, thereby creating high turbidity in the river. The study also found that TSS load under natural background conditions stayed under the turbidity standard of 50 NTU in the Haw River. More recent flow separated/dependent water quality analysis supports these findings described by the TMDL at station B114000 as well as at several upstream co-located AMS/USGS stations in the Reedy Fork/Buffalo Creek Watershed, especially those in urban settings like B0540000 and B0670000 (*Figure 6-17, Figure 6-78*). The turbidity and TSS loading at B1140000 appear to be driven by high-flow events ( $\geq 75^{\text{th}}$  percentile flows;  $\geq 574$  cfs) with the mean turbidity concentrations of 57.5 NTU versus 11.5 and 4.4 NTU at medium and low flows ( $\leq 25^{\text{th}}$  percentile flows;  $\leq 156$  cfs), respectively (*Figure 6-78; Table 6-37*). There is a description of how this data is processed in Section 6.3.

*Table 6-37: Haw River Flow Separated (2002-2020) Mean Water Quality Concentrations at AMS Station B1140000 using Flow from USGS Gage 02096500.*

Water Quality Parameter	Low Flow	Medium Flow	High Flow
Flow (cfs)	$\leq 156$	157-573	$\geq 574$
Turbidity (NTU)	4.4	11.5	<b>57.5</b>
TSS (mg/L)	6.3	9.7	<b>61.4</b>
Fecal Coliform Bacteria (cfu/100 mL)	79	232	<b>1557</b>
NO <sub>x</sub> (mg/L)	<b>3.69</b>	1.86	0.89
TKN (mg/L)	<b>1.03</b>	0.85	0.88
NH <sub>3</sub> (mg/L)	0.048	0.076	<b>0.088</b>
TP (mg/L)	<b>0.26</b>	0.19	0.22
Conductivity ( $\mu\text{s}/\text{cm}$ @25°C)	<b>430</b>	255	154
pH (s.u.)	<b>8.2</b>	7.8	7.4
DO (mg/L)	9.7	10.3	<b>10.7</b>

Haw River at Haw River; Low flows  $\leq 25^{\text{th}}$  percentile; Medium flows between 26<sup>th</sup> and 74<sup>th</sup> percentile; High flows  $\geq 75^{\text{th}}$  percentile. Flow statistics based on 1991-2020 data.

The entire length of the Haw River in this HUC-10 (0303000204) is currently (2022 IR) rated as data inconclusive (3a and 3i) due to the elevated turbidity concentrations that vary from year to year (*Table 6-36*). The five-year mean turbidity levels show that the turbidity concentrations are fairly consistent throughout this watershed with a few exceptions, such as B1140000 in the 2015-2019 timeframe (*Figure 6-79*). There was a large spike in turbidity, TSS, fecal coliform bacteria, phosphorus and TKN on September 29, 2015, which resulted in a higher overall turbidity mean as seen in *Figure 6-79 (Table 6-38)*. No other stations in this watershed were monitored on this date, so the spike was not captured throughout the watershed. There was a 0.84-inch rainfall recorded at the Burlington-Alamance Regional Airport on this date. This spike is evidence that there are nonpoint sources contributing to elevated pollutant concentrations, however the exact source/sources were not identified. This is a good example of how high flows can contribute to a large load of pollutants that are carried into a system by stormwater runoff.

Figure 6-78: Flow Separated Mean Concentration for Turbidity, TSS and Fecal Coliform Bacteria (2002-2020) at Station B1140000 in the Haw River at USGS Gage Station 02096500 (1991-2020).

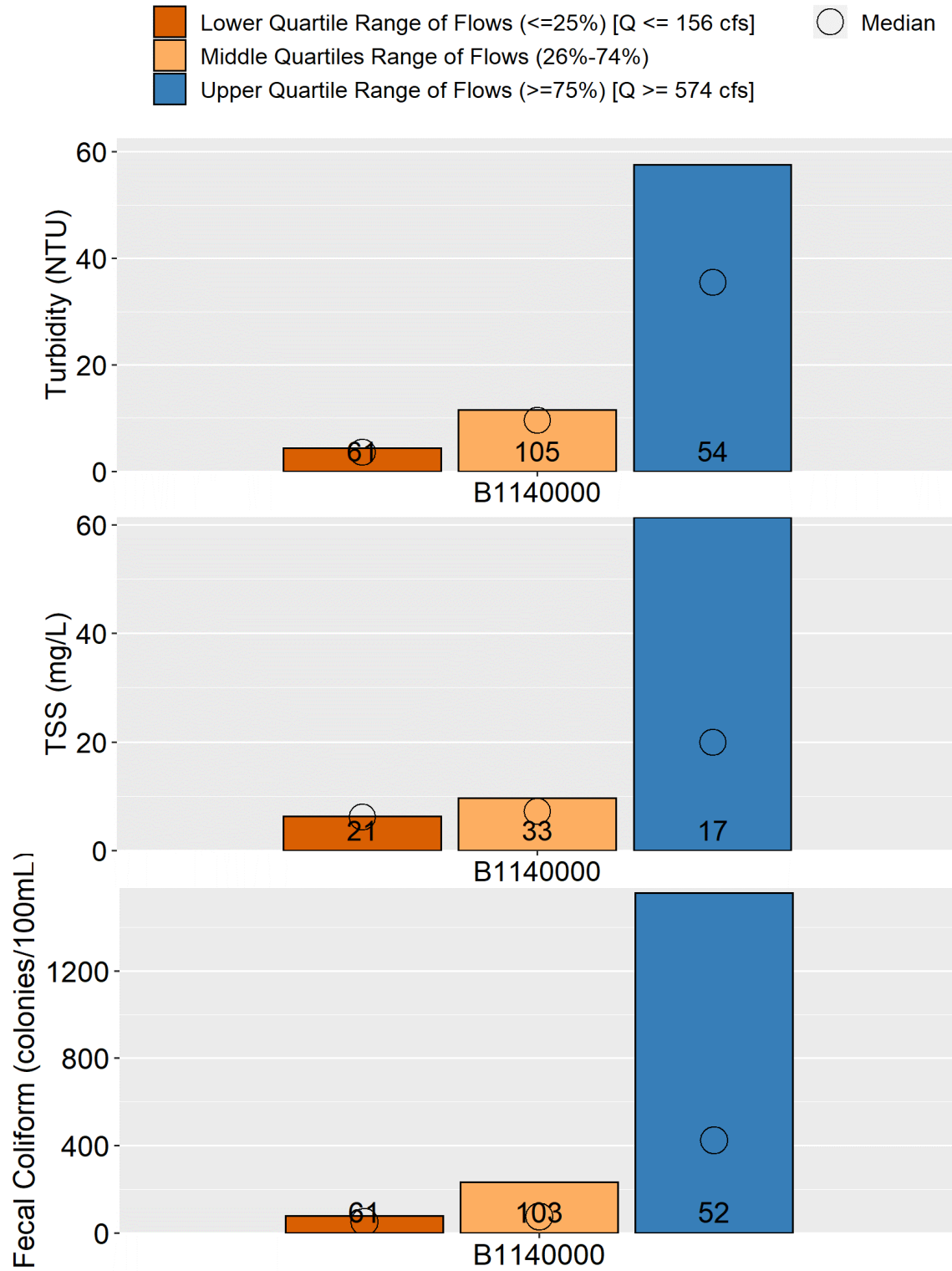
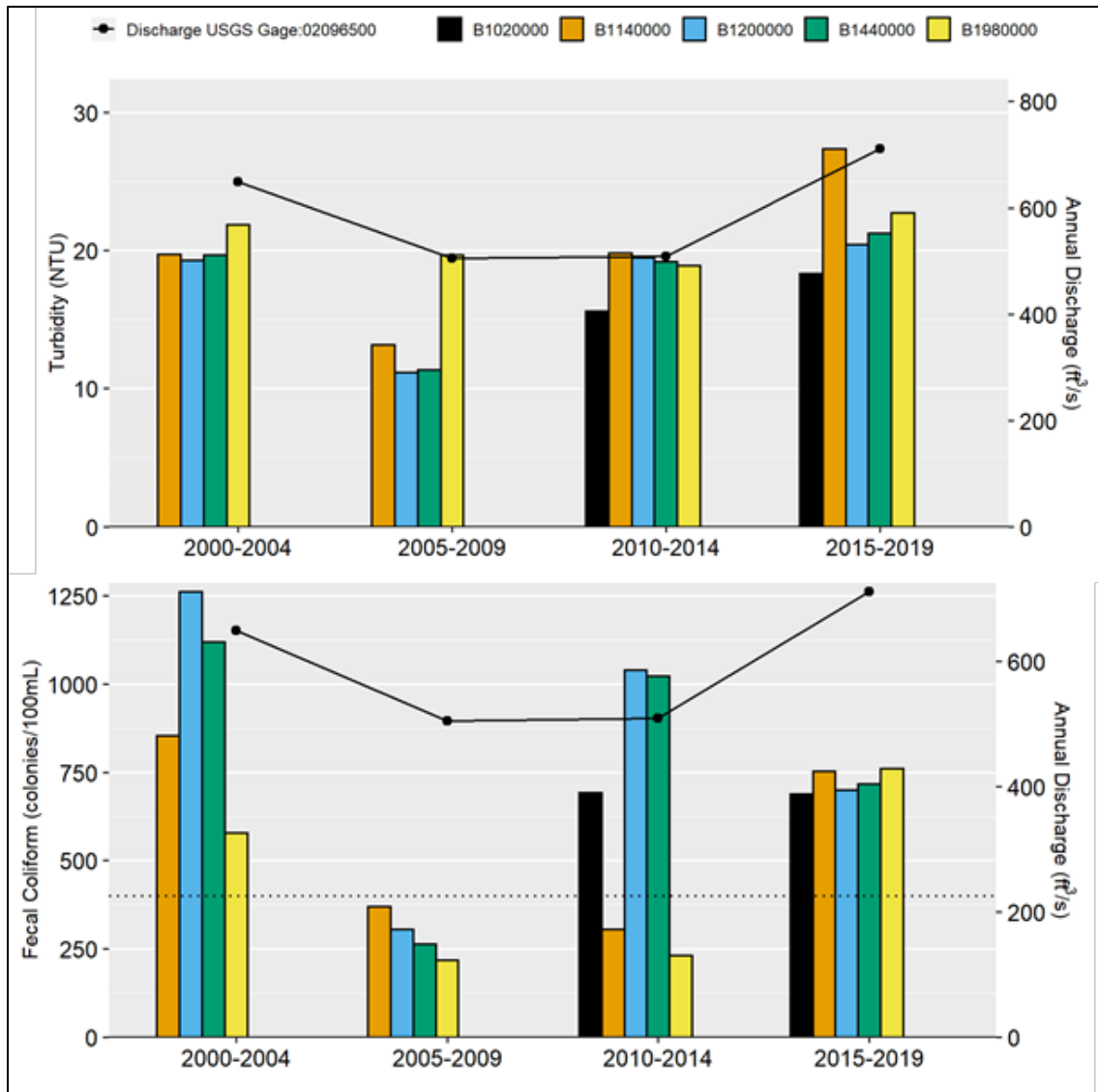


Figure 6-79: Five-Year Average Turbidity and Fecal Coliform Bacteria Concentrations in the Mainstem Haw River in HUC 0303000204 Plus the Downstream Station B1950000 with Stream Flow at Haw River at Haw River USGS Gage Station 02096500.



The TMDL indicated that there was a need to reduce the turbidity load by 61% in order to meet the standard in the Haw River. DWR conducted a seasonal Mann-Kendall trend test for turbidity at station B1140000 over the 2000-2019 and 2010-2019 timeframe and did not find a significant difference (calculated at 95% confidence), indicating that the reductions needed to meet the TMDL have not likely occurred (*Table 6-27*). An overall recommendation from the TMDL is for DEMLR and other relevant agencies (including county and municipal entities) overseeing construction activities to perform a higher degree of review in the construction permit review process and execute more thorough compliance evaluations. Greater compliance with stormwater control measures and oversight of construction activities can protect the watershed. To achieve better compliance, more resources (i.e., financial, staff)

are needed for pre- and post-construction activities. State stormwater rules may also need to be reevaluated to provide sufficient volume control during larger storm events.

Table 6-38: Haw River Ambient Water Quality Data for Station B1140000 at NC 49 for September 29, 2015, and Summary Data for 2015-2019 and 2016-2020.

Water Quality Parameter	B1140000 9/29/2015*	2015-2019 Mean	2015-2019 Median	2016-2020 Mean
Turbidity	400 NTU	27.4	10.0	24.8
TSS	592 mg/L	52.6	7.3	21.8
Fecal Coliform	1500 cfu	754	91	771
pH	6.6	7.6	7.7	7.58
DO	7.3 mg/L	10.0	9.4	10.0
Conductivity	95 $\mu$ s/cm @25°C	275	230	250
NO <sub>x</sub>	0.48 mg/L	2.14	1.60	1.95
TKN	2.8 mg/L	1.00	0.95	0.88
NH <sub>3</sub>	0.14 mg/L	0.08	0.03	0.04
TP	1.1 mg/L	0.23	0.16	0.20
Temperature	20.9 °C	17.8	19.0	17.6
Average Daily Flow <sup>^</sup>	3,280 cfs	Yearly Average Flow Range 2015-2019 485cfs - 1,091 cfs		Yearly Average Flow Range 2016-2020 485cfs - 1,188 cfs

\*9/29/2015 – date with maximum Turbidity and TSS values occurred likely due to a storm event (0.84" rainfall), resulting in nonpoint source runoff in the watershed.

<sup>^</sup>USGS gage 02096500 Haw River at Haw River (7Q10 = 60 cfs; September mean flow = 524 cfs; Annual mean flow = 625 cfs (USGS StreamStats 4/13/22).

Orange denotes values greater than the 5-year mean and median, likely due to pollutant loading from runoff or stream bank erosion.

Green denotes values less than the 5-year mean and median, likely due to dilution effects from the additional flow.

The entire length of the Haw River in this HUC-10 (0303000204) is also currently (2022 IR) rated as data inconclusive (3a) or impaired (4t) due to the elevated fecal coliform bacteria concentrations that vary from year to year (Table 6-36). The five-year mean fecal coliform bacteria show that the bacteria concentrations were fairly consistent throughout this watershed only in the 2015-2019 timeframe (Figure 6-79). There is a fecal coliform bacteria TMDL for the same segment of the Haw River (from NC87 to NC49). The TMDL assessment found that the 400 cfu/100 mL bacteria criteria violations occurred at both high and low flows, suggesting that contamination occurred during both wet and dry weather conditions. The flow separated/dependent water quality analysis of the data collected between 2002 and 2020 shows a mean fecal coliform bacteria concentration at the high flows of 1557 cfu/100mL in comparison to 232 and 79 cfu/100mL at medium and low flows, respectively (Figure 6-78 and Table 6-37). A non-seasonal Mann-Kendall trend test for fecal coliform bacteria concentrations found a significant increasing trend at stations B1140000 from data collected from 2010-2019 (calculated at 95% confidence); indicating that additional measures are needed to achieve the required 77% load reduction to meet the TMDL. The TMDL concluded that the combination of leaky sewer pipes (collection systems), failing septic systems and direct pipeline had elevated the fecal coliform during dry weather/low flow in the river and, correspondingly, nonpoint sources and sporadic sources such as sanitary sewer overflows had elevated the fecal coliform during high flows.

Figure 6-80: Five-Year Average Total Nitrogen and Total Phosphorus Concentrations in the Mainstem Haw River in HUC 0303000204 Plus the Downstream Station B1950000 with Stream Flow at Haw River at Haw River USGS Gage Station 02096500.

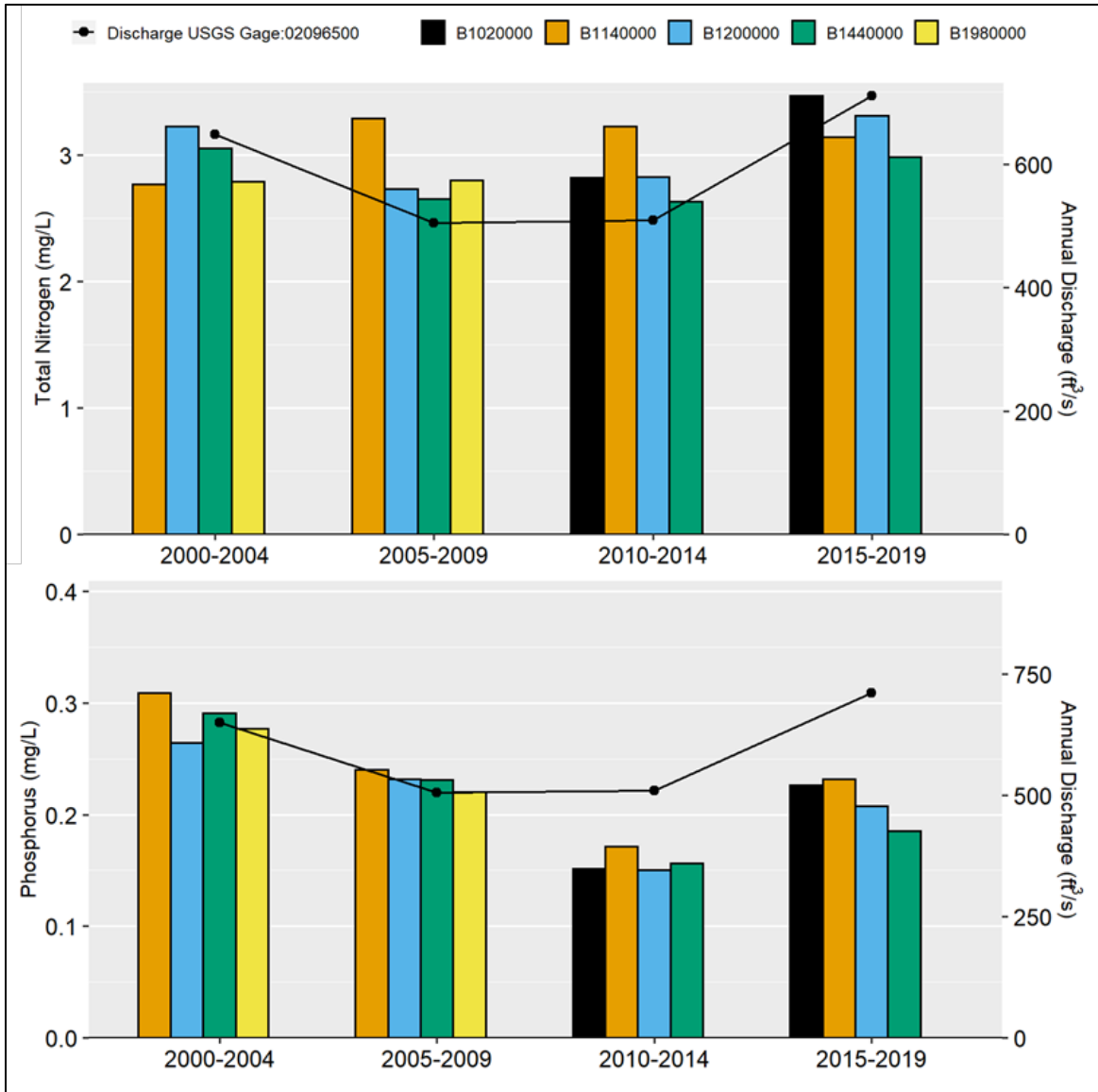
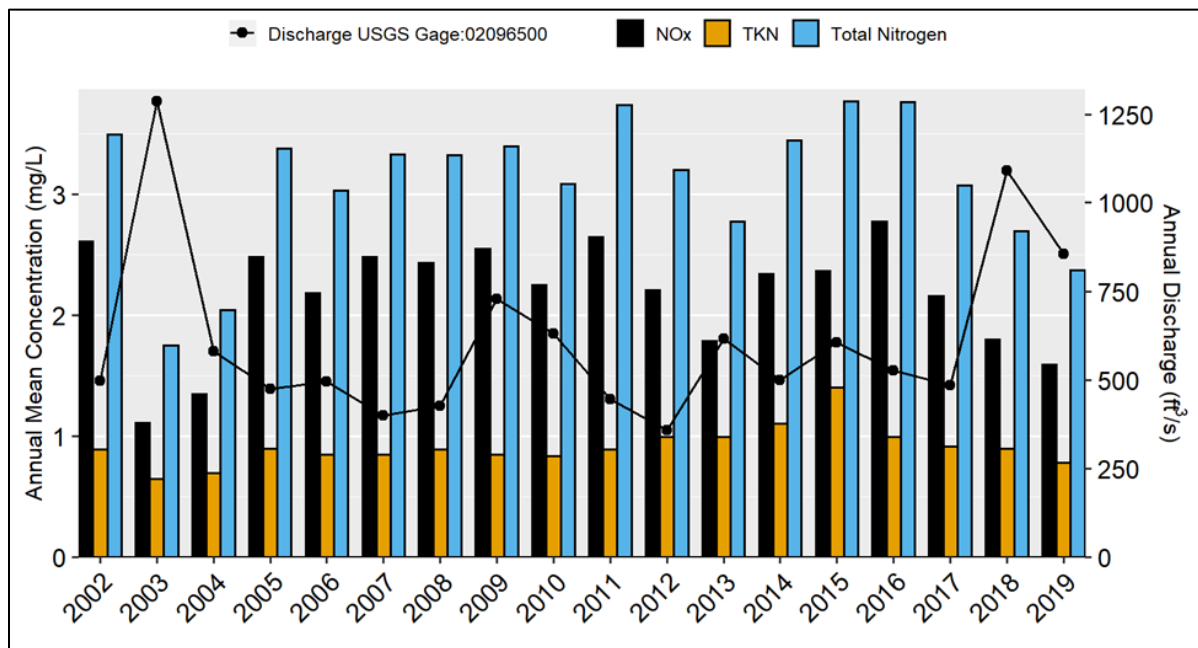


Figure 6-81: Haw River Nitrogen Constituent Concentration at Station B1140000 between 2002 and 2019.



The entire length of the Haw River mainstem in this HUC-10 (0303000204) has elevated concentrations of nitrogen and phosphorus and is largely influenced by point source nutrient contributions. The mainstem Haw River instream total nitrogen concentrations jump up considerably from the concentrations seen in the headwater Haw River subwatershed which drains directly to it (*Table 6-10* and *Table 6-27*). The TN and TP five-year mean concentrations increase from 1.20 and 0.10 at station B0210000 in the headwater Haw River mainstem to 2.91 and 0.23 at station B1020000 in the Back Creek-Haw River subwatershed mainstem Haw River, respectively (*Table 6-27*). The Back Creek-Haw River subwatershed have the second highest 2022 IR five-year mean TN and TP concentration at 2.23 and 0.16 mg/L respectively, behind the Reedy Fork subwatershed (*Table 6-10*).

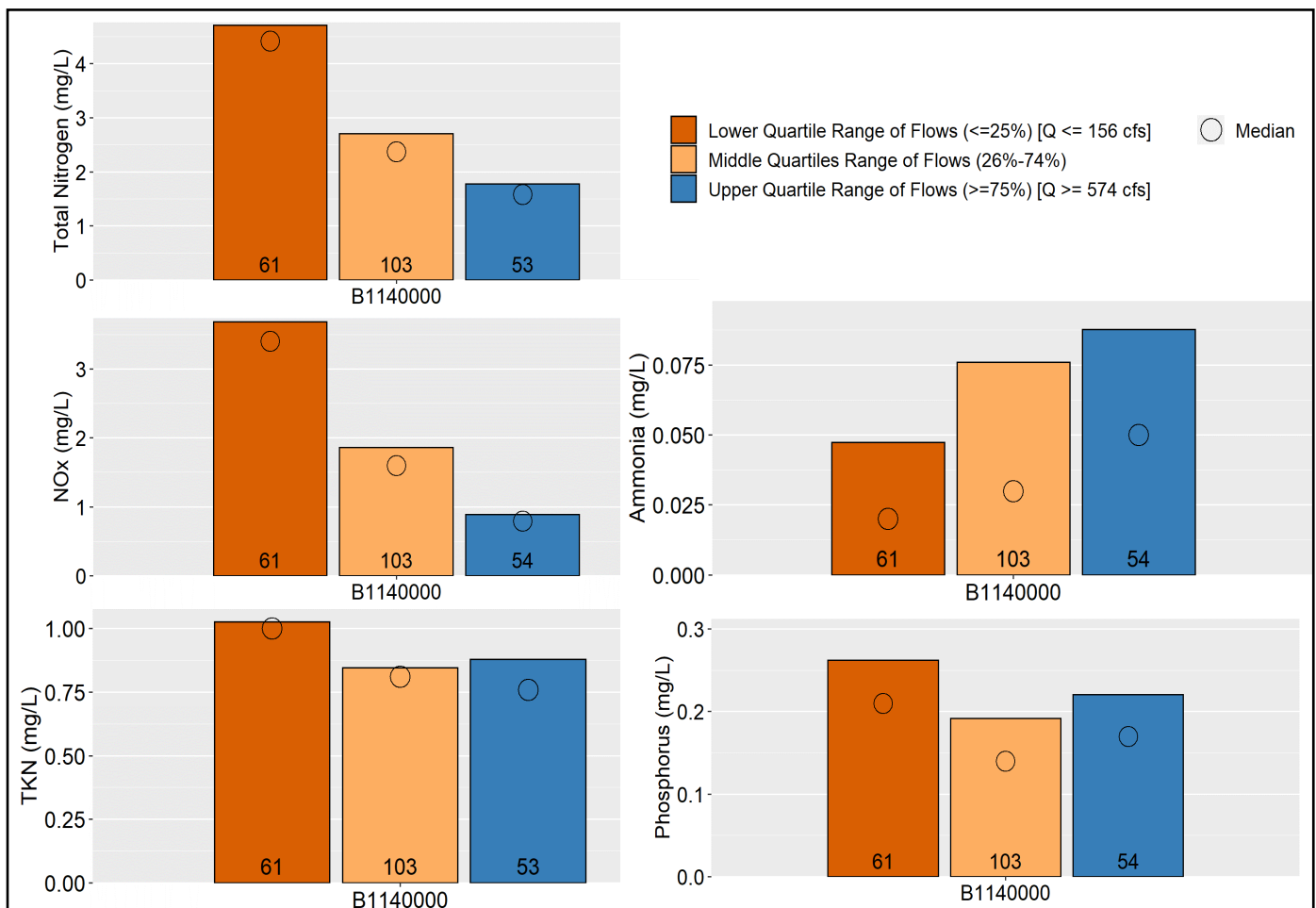
Two of the three major wastewater treatment plants in this HUC (0303000204) discharge directly to the mainstem Haw River, which also receives drainage from the entire Reedy Fork watershed. The concentrations are fairly similar throughout the mainstem Haw River and vary somewhat depending on flow (*Figure 6-80*). Nitrate concentrations account for approximately two-thirds of the TN concentration and the major contributing source is generally wastewater (*Figure 6-81*).

- The yearly mean total nitrogen concentration at station B1140000 over the five-year period between 2015-2019, ranged between 2.69 and 3.77 mg/L, with a maximum recorded single day concentration of 8.9 mg/L which occurred on September 22, 2015, when there was an average daily low flow of 60.6 cfs [USGS reported 7Q10 is 60 cfs (Gage # 02096500)].
- The yearly mean NOx concentration ranged between 1.59 and 2.77 mg/L, with a maximum single day concentration of concentration of 7.7 mg/L occurring on the same day (September 22, 2015).
- In contrast, the TKN ranged between 0.78 and 1.40 mg/L with a maximum single day concentration of 2.8 mg/L occurring on September 29, 2015, during a high flow event (3,280 cfs;

corresponds with the high turbidity event discussed above; *Table 6-38*). For comparison, a TKN concentration of 1.2 mg/L was recorded on September 22, 2015, during the low-flow, high instream NO<sub>x</sub> concentration.

Station B1140000 is co-located with the USGS stream gage so the flow separated/dependent analysis provides a more in-depth assessment of how flow directly impacts the concentrations of nutrients and other water quality parameters at this station (*Table 6-37* and *Figure 6-82*). The mean and median concentration of nutrient including nitrate, TKN, and phosphorus are higher at low flows ( $\leq 25^{\text{th}}$  percentile flows;  $\leq 156$  cfs), indicating that the sources influencing the instream concentration during low-flow period are likely influenced by point source discharges, where ammonia concentration are somewhat higher at high flows ( $\geq 75^{\text{th}}$  percentile flows;  $\geq 574$  cfs) (*Table 6-37* and *Figure 6-82*). The sources of ammonia during high flow events could be related to sanitary sewer overflows, wastewater treatment plant issues and other nonpoint sources. While high flows can dilute the contributions from point sources, they also carry pollutants into the system as discussed above.

*Figure 6-82: Eighteen Year (2002-2020) Flow Separated Mean Concentration for Total Nitrogen, Nitrate, TKN, Ammonia and Total Phosphorus at Station B1140000 in the Haw River at USGS Gage Station 02096500.*



The two major wastewater dischargers to the mainstem Haw River in this HUC-10 include the 12.0 MGD Burlington Eastside WWTP (NC0023268) and the 3.5 MGD Graham WWTP (NC0021211). Both wastewater treatment plants are subject to the Jordan Lake Water Supply Nutrient Strategy: Wastewater Discharge Requirements (15A NCAC 02B .0270) which requires a nitrogen and phosphorus TMDL reduction goal of 8% and 5%, respectively, from the 1997-2001 baseline load.

The City of Burlington’s Eastside WWTP discharges to the Haw River about 600 feet upstream of Hwy 70 bridge and about 0.7 miles upstream of AMS station B1140000. According to the draft NPDES permit fact sheet, their average flow for the period of January 2018-August 2022 was 4.5 MGD with a mean TN concentration of 12.2 mg/L and TP of 0.3 mg/L. The City of Burlington received a combined allocation for their two treatment plants [Southside WWTP (NC0023876) discharges to Big Alamance Creek and Eastside WWTP (NC0023868) discharges to the mainstem Haw River] for a total nitrogen (TN) allocation of 386,156 lbs/yr (effective January 1, 2018) and 48,540 lbs/yr total phosphorus (TP) (effective January 1, 2010) (*Table 6-31*). Both of Burlington’s wastewater treatment plants have a designed treatment capacity of 12 MGD. Treatment plant upgrades were made in 2013 to assist with nutrient removal.

The City of Burlington signed a memorandum of agreement ([MOA](#)) with the Haw River Assembly on October 22, 2020, to formalize a commitment by the city to test, analyze, and examine potential sources of PFAS and 1,4-dioxane compounds discharged from the City’s two WWTPs (City of Burlington [website](#) and [Oct. 22, 2020 media information release](#)). For more specific information on 1,4-dioxane and the City of Burlington’s efforts to address this contaminant, see Chapter 13.

The City of Graham discharges to the Haw River about 600 feet downstream of Hwy 54 and UCFRBA ambient station B1200000. According to their NPDES permit fact sheet, their average flow for the period of June 2017-May 2021 was 1.98 MGD with a mean TN concentration of 9.80 mg/L and TP concentration of 0.5 mg/L. Their 3.5 MGD NPDES permit was renewed April 1, 2022, with an expansion flow tier of 5.0 MGD. The City of Graham’s TP allocation limit of 7,079 lbs/yr was effective January 1, 2010, and their TN limit of 56,315 lbs/yr was effective January 1, 2019 (*Table 6-39*). The treatment plant made a significant reduction in their TN load between 2018 and 2019 to achieve their TN limit in 2019 (*Table 6-39*). There is an effluent monitoring requirement included in their permit for 1,4-Dioxane and a reopener clause [A. (10)] that allows the Director of DWR to modify the permit requirements to address 1,4-Dioxane monitoring, treatment and/or compliance upon evaluation of collected monitoring data for potential effluent limits.

*Table 6-39: Graham WWTP Annual Total Nitrogen and Total Phosphorus Jordan Lake Allocation and their Yearly Load between 2018 and 2022.*

Graham WWTP NC0021211	Allocation lbs/yr	Delivery Factor	2018 lbs/yr	2019 lbs/yr	2020 lbs/yr	2021 lbs/yr	2022 lbs/yr
<b>Total Nitrogen</b>	56,315	66%	100,683	40,303	36,435	34,733	30,390
<b>Total Phosphorus</b>	7,079	56%	4,319	2,946	2,694	2,354	6,803

Jordan Lake nutrient strategy (15A NCAC 02B .0262)

Both the city of Burlington and Graham are members of the Haw River Nutrient Compliance Association (NCC000003) which allows the members to work collectively to meet the point source nutrient targets in the Haw River subwatershed.

Benthic community station BB022 is ~6.5 km downstream of a major wastewater treatment plant (Burlington Eastside) and drains the urban areas of Burlington and northern Greensboro. It has been sampled 10 times since 1983. Despite the growth in urban development, the bioclassification has consistently been Good-Fair since 1987, suggesting some input of higher-quality waters from the northern portion of the watershed. Habitat at this station was deficient particularly in regard to poor quality riffles with a high degree of embeddedness. Siltation was also of concern but is typical in urbanized rivers. In 2018, EPT richness received its highest rating since monitoring began in 1983 with 23 taxa. The majority of EPT taxa were represented by the mayfly (Ephemeroptera) families Baetidae and Heptageniidae and the caddisfly (Trichoptera) family Hydropsychidae, which accounted for over 65% of the total EPT richness. No stoneflies (Plecoptera) were present. Typical of streams receiving urban runoff, specific conductance at this location was relatively high (348  $\mu\text{S}/\text{cm}$ ). The habitat score at this location was a 58 (out of 100) due to poor riffle habitats, highly embedded substrate and sparse riparian vegetation.



BB022	
Year	Bioclassification
2008	Good-Fair
2018	Good-Fair

#### 6.6.4.6 Back Creek – Haw River Watershed Summary

Best management practices to address nutrients, fecal coliform bacteria, turbidity/sedimentation and volume control are necessary to improve water quality throughout the Back Creek-Haw River watershed.

The Back Creek-Haw River subwatershed five-year mean concentrations of nutrients, TSS, bacteria and specific conductance/conductivity are all much higher than the Headwater Haw River subwatershed (0303000202) that drains to it. The TN mean increased from 0.98 mg/L in the Headwater Haw River subwatershed to 2.23 mg/L in the Back Creek subwatershed (*Table 6-10*). The development of rules to reduce nutrient loading to Jordan Lake will ultimately improve the water quality throughout the entire system and result in localized improvements seen in each section as both point and nonpoint nutrient reductions are implemented.

Stony Creek and Back Creek/Graham-Mebane Reservoirs are impaired due to elevated nutrient concentrations resulting in excessive biological productivity and excursions of the chlorophyll *a* standard. Lake Burlington was also identified as eutrophic and in need of protection from additional nutrients draining to the lake (*Figure 6-70*).

There are turbidity and fecal coliform bacteria TMDLs for several sections of the Back Creek-Haw River subwatershed. The data collected throughout much of this watershed continue to show elevated concentration of both parameters (*Table 6-27* and *Table 6-34*). Trend analysis indicated that the

concentrations have either remained consistently elevated or are continuing to increase at many of the stations assessed.

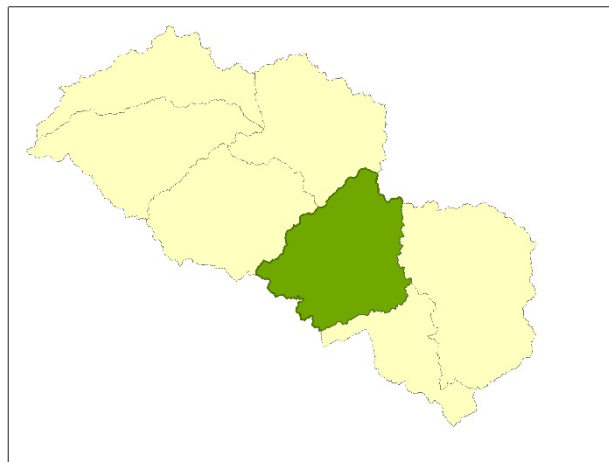
Recommendations to address water quality concerns throughout this watershed include:

- Implement BMPs to reduce nutrient loading to the smaller reservoir watersheds. These will ultimately help improve loading to Jordan Lake as well.
- SWCD should work with willing landowners to implement BMPs to reduce the flashiness, turbidity, and fecal coliform from entering the stream system throughout the Stony Creek and the whole Back Creek-Haw River subwatershed.
- Implement urban stormwater control measures to address fecal, sediment and nutrients from entering Town Branch and to address any collection system issues throughout the watershed to reduce bacteria and nutrient from entering surface waters.
- The City of Graham should connect the existing septic/unsewered neighborhood to their municipal wastewater treatment facility to eliminate the source from older, less efficient and failing septic systems (TMDL recommendation).
- DEMLR and other relevant agencies (including county and municipal entities) overseeing construction activities should perform a higher degree of review in the construction permit review process and execute more thorough compliance evaluations. Greater compliance with stormwater control measures and oversight of construction activities can protect the watershed. To achieve better compliance more resources (i.e., financial and staff) are need for pre and post construction activities (TMDL recommendation).
- Urban areas need to implement stormwater management controls on new and existing developed lands controls to address existing development pressures resulting in impairments.
- DWR should add nutrient monitoring to station B1095000 in Jordan Creek to help understand the overall nutrient impacts coming from this watershed to Stony Creek Reservoir.

#### 6.6.5 Cane Creek – Haw River Watershed (0303000205)

Includes: Haw River, Cane Creek, Haw Creek, Terrells Creek, Terrells/Ferrells Creek, Collins Creek & Marys Creek, Varnals Creek

Cane Creek-Haw River watershed 0303000205 is the lower portion of the old DWQ subbasin 03-06-02 and the upper half of 03-06-04 (see Chapter 1). The most common land use in 2019 was forest (57.5%) and agriculture (27.4%) with 9.3% designated as developed (*Table 6-5*). This 270 mi<sup>2</sup> subwatershed is the second largest in the Haw River subbasin behind B. Everett Jordan Lake-New Hope River (343 mi<sup>2</sup>). This subwatershed also has the lowest population density in the subbasin (138 people/mi<sup>2</sup>). The population grew by approximately 6,000 people between 2010 and 2020 (*Table 6-4*).



The majority of the impacts in this watershed are related to habitat degradation, resulting in stream impairments due to insufficient macroinvertebrate community structure and health (*Table 6-40*).

The Haw River in this watershed flows approximately 19 miles from the confluence with Big Alamance Creek near Swepsonville to the confluence with Terrells Creek (north side). There are two ambient water quality stations and two benthic macroinvertebrate stations on the mainstem Haw River. As in the upstream Haw River segments, elevated fecal coliform bacteria and turbidity continue to be issues that require coordinated efforts throughout the watershed to reduce the loading of these pollutants and improve water quality and aquatic habitat.

*Table 6-40: 2022 IR Water Quality Impairments by Stream Segment (AU#) for Cane Creek-Haw River HUC 0303000205.*

Stream Name	Stream AU#	Classification	Description	Impairment Parameter (IR category)
Haw Creek	16-20-(4)	WS-V; NSW	From Hwy 54 to Haw River	Benthos (5)
Varnals Creek	16-21a	WS-V; NSW	From source to Rock Creek	Benthos (5)
Cane Creek (Cane Creek Reservoir)	16-27-(2.5)a	WS-II; HQW; CA; NSW	From a point 0.4 miles upstream of Turkey Creek to UT 0.5 miles downstream of SR 1114	Benthos (5)
Collins Creek	16-30-(0.5)a	WS-V; NSW	From source to a point 0.6 miles downstream of SR 1006	Benthos (5)
Collins Creek	16-30-(1.5)	WS-IV; NSW	From a point 0.8 miles downstream of Orange County SR 1005 to Haw River	Benthos (5)
Terrells Creek (South Side Haw River)	16-31-(2.5)	WS-IV; NSW	From Cattail Creek to Haw River	Benthos (5)
Terrells Cr./Ferrells Cr. (North Side Haw River)	16-32	WS-IV; NSW	From source to Haw River	Benthos (5)

As of 2022, there were seven minor NPDES wastewater discharge facilities and 20 separate NPDES single-family permits with a combined as-built discharge of 0.07252 MGD (65,500 gpd for the minor facilities and 7,020 gpd for the single-family). The minor facilities included four package plants that discharged to Collins Creek, Cane Creek and the Haw River. Other watershed permits included seven AFOs permitted for 2,627 head count and 2,838,800 lbs live weight (five cattle, one swine and one animal individual state permit), 12 NPDES permits and 12 state stormwater facilities. There were also 2,537 permitted fields in this watershed for non-discharge wastewater irrigation and residual solids land application. Most of the fields were residual solids land application associated with the City of Burlington (WQ0000520; 1,926 acres) and the Orange Water and Sewer Authority (WQ0001169; 514 acres). The wastewater irrigation fields (approximately 15 acres) were primarily associated with three permitted facilities, Carolina Research Center WWTF (WQ0024508), Bingham Woods MHP WWTF (WQ0005279), and Bingham Facility WWTF (WQ0023896). There were also 14 individual permitted very small wastewater irrigation fields associated with single-family dwelling that generally range from 1/10 to half an acre in size.

For this assessment (2002-2020), there were two ambient stream monitoring stations (one AMS, one UCFRBA coalition), two RAMS stations, 13 benthic macroinvertebrate (including both basin and special study sites) and six fish community stations used to assess the water quality conditions (*Table 6-41*). Ambient and biology stations discussed in this section were used in the 2022 IR. A complete list of all 2002 to 2020 stations is located in the Chapter 2 Appendix.

*Table 6-41: Cane Creek-Haw River (0303000205) Ambient Monitoring Stations Collected by DWR and the Upper Cape Fear River Basin Association Monitoring Coalition.*

Station ID	Station Location	Monitoring Program*	County	Stream AU#	Stream Classification + NSW	HUC 12
B1972000	VARNALS CRK AT SR 2116 NR SWEPSONVILLE	RAMS	Alamance	16-21b	WS-V	30300020502
B1980000	HAW RIV AT SR 2171 AT SAXAPAHAW	AMS	Alamance	16-(10.5)e	WS-V	30300020506
B19850000	LONG BRANCH AT STOCKARD RD NR SNOW CAMP	RAMS	Alamance	16-26-1	WS-V	30300020506
B2000000	HAW RIV AT SR 1005 NR SAXAPAHAW	UCFRBA	Alamance	16-(10.5)e	WS-V	30300020506

Monitoring Program\*: AMS = DWR Ambient Monitoring System; UCFRBA = Upper Cape Fear River Basin Association; RAMS=DWR Random Ambient Monitoring System. Green highlighted stations no longer sampled.

The only EPA approved TMDL in this HUC was the addition of the Cane Creek Reservoir in 2010 as an addendum to the Jordan Lake TMDL and requires nutrient load reductions from all sources in the watershed similar to the Haw River arm of the Jordan Lake Rules (*Table 6-12*).

#### 6.6.5.1 Haw Creek

Haw Creek [AU# 6-20-(4); WS-V; NSW] from NC Hwy 54 to Haw River drains southeast Mebane and a mixture of urban, suburban, agricultural and forested areas. This stream is impaired (2022 IR) for aquatic life (*Table 6-40*). Benthic community station BB374 is located about a mile upstream of its confluence with the Haw River at Swepsonville Saxapahaw Rd. This station received a Good bioclassification result in 1998; however, this station has received Fair bioclassification ratings since 2008.



This station was last sampled in 2018, in May and June, and in both instances received a Fair bioclassification. In previous assessments, the decline in EPT richness had been attributed in part to drought that affected the catchment in 2007. However, over a decade later, the bioclassification at this station remains unchanged, indicating that other factors may be contributing to the lack of community recovery. Habitat deficiencies that contribute to siltation and that are typical in areas of high development were noted, including moderate to severe bank erosion and lack of good

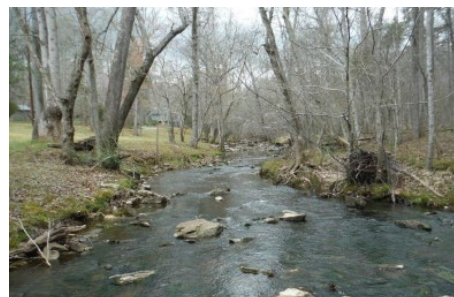
riparian vegetation. The stream likely suffers from severe erosion, extreme rain and/or drought events, poor riparian zones in more developed reaches, and upstream construction and agricultural activities leading to sedimentation. The habitat scores at this location in 2018 were 74 and 75 (out of 100), respectively, due to lack of instream habitat and severe bank erosion. These scores are consistent with previous scores dating back to 1998.

At a co-located fish community at station BF55, a diverse assemblage was collected in 2018, yet with slightly lower species richness and total abundance than in past assessments and no pollution intolerant species collected. However, one additional sucker species (brassy jumprock, n=1, new record) and two largemouth bass were collected in 2018, resulting in a four-point increase in total NCIBI score, and a return to a Good bioclassification. Historically, this site has had a highly diverse fish community, with more than 30 fish species collected from this location. Three of the four fish community assessments conducted here since 2003 have resulted in Good NCIBI ratings, indicating relative stability in fish habitat quality and water quality in this watershed.

BB374	
Year	Bioclassification
2008	Fair
2013	Not Rated
2018	Fair
2018	Fair
BF55	
2003	Good
2009	Good
2013	Good-Fair
2018	Good

#### 6.6.5.2 Varnals Creek

Varnals Creek drains central Alamance County and is a predominately forested watershed with some agriculture. Varnals Creel (AU #16-21a; WS-V; NSW) from the source to Rock Creek is impaired (2022 IR) due to a Fair benthic macroinvertebrate rating at station BB390 (Table 6-40). Biologists noted that instream habitat here is gravel- and sand-dominated, which may have contributed to the lower bioclassification. However, considering the forested nature of the watershed and higher fish and benthos scores at the downstream sites, this site should be sampled again in 2023 to determine if the impairment to the benthos community persists.



Varnals Creek (AU# 16-21b; WS-V; NSW) from Rock Creek to Haw River is supporting due to a Good ratings at co-located fish community station BF119 and benthic community station BB359.

In 2018, a few less species were collected at site BF119 than in 2013, but there was still good diversity for this small watershed. The total abundance in 2018 was less than half of what was collected in 2013 (157 and 426, respectively). Overall, the fish community remains trophically balanced here, but still no intolerant species are present. Three bluegill were observed with popeye (nematode parasite), but otherwise no disease was observed. Habitat qualities at this location

BB390*	
Year	Bioclassification
2000	Fair
BF119	
2004	Good
2009	Excellent
2013	Good
2018	Good
BB359	
2000	Good
2014	Good

remain high, and the site has now been rated Good in three of the four fish sampling assessments since 2004. Despite a very minor drop in total NCIBI score in 2018, water quality continues to be Good in this small, mixed-use watershed.

#### 6.6.5.3 *Marys Creek*

Marys Creek (AU# 16-26; WS-V; NSW) is a tributary to the Haw River draining an eastern area of Alamance County. The biological community in this stream is monitored at benthic community station BB377 (Whitney Rd). This stream was rated Good for the second consecutive benthic basinwide sample in 2018. The 2018 EPT richness and EPTBI were very close to that observed in 2009. Marys Creek was one of the streams sampled as part of a drought recovery study that occurred following the 2002 drought (BAU memo, B-20040823) to determine benthic fauna recovery times. It appears EPT fauna has recovered since the drought in 2002 and that the stream is likely affected by extreme hydrologic flow fluctuations common in slate belts streams with low water tables. Flow fluctuations coupled with upstream nonpoint pollution sources are likely the most important factors altering water quality in Marys Creek. Future benthic sampling is recommended to assess changes in water quality in this catchment.

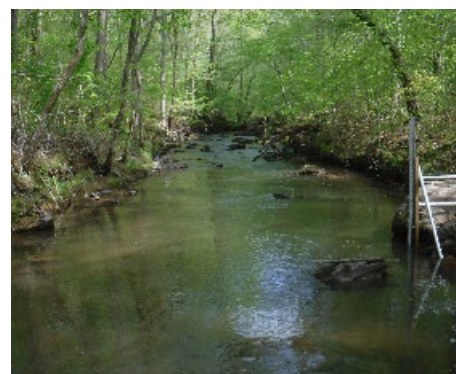


BB377	
Year	Bioclassification
2009	Good
2018	Good
BF101	
2004	Excellent
2009	Good
2013	Good

The number of fish collected at the co-located site BF101 has been relatively stable. In 2013, there was a slight decrease in the NCIBI score due to loss of a species of sunfish; however, there was no change in the rating. This community is very diverse for a stream of its size; there are 32 species known from this site. This is likely related to the site’s proximity to the river which allows species to migrate to and from the river. BF101 is more so affected by low flows and droughts as are many Carolina Slate Belt streams. Based upon all the data collected, there was no change in water quality in the Marys Creek watershed, but basinwide assessment sampling should be continued in 2023 to document any impacts from changing land use in the watershed.

#### 6.6.5.4 *Cane Creek*

Cane Creek from source to the dam at Cane Creek reservoir is classified as Water Supply-II (WS-II), High Quality Waters (HQW) and Nutrient Sensitive Waters (NSW). These classifications provide for extra water quality protections in order to safeguard the watershed against inputs that can directly impact the water supply. There are a lot of non-discharge residual fields in the small subwatershed that are believed to be impacting the water supply water quality. Several municipalities have designated land application fields in the subwatershed (City of Burlington and Graham, Orange Water and Sewer Authority). Work is being done to determine if this is a potential source of emerging contaminants to surface waters.



Cane Creek (Cane Creek Reservoir) [AU# 16-27-(2.5)a; WS-II; NSW] from a point 0.4 miles upstream of Turkey Creek to the UT 0.5 miles downstream of SR 1114/Buckhorn Rd is listed as Impaired for aquatic life on the current 2022 IR due to a Fair rating at site BB241 (Table 6-40). Cane Creek at benthic monitoring station BB241 has exhibited a relatively stable macroinvertebrate community with all samples since July 2003, producing Good-Fair bioclassifications until 2018.

BB241	
Year	Bioclassification
2009	Good-Fair
2012	Good-Fair
2018	Fair
2021	Good-Fair

Development and agriculture have increased in this catchment since 1992 and benthic metrics at this station have slowly declined since. It appears that the mostly intolerant EPT taxa declined significantly between 2009 (EPTS = 18) and 2012 (EPTS = 9) and based on the 2018 sample this station received its first Fair benthic bioclassification. High amounts of precipitation, such as that observed in 2018, can lead to increased nonpoint source pollution runoff and result in declining water quality. The EPTBI (5.09) was the highest recorded from this location since sampling began in 1986 and suggests decreases in the abundance of intolerant taxa. Intolerant taxa were present but were very low in richness and abundance. Most recent sampling at this station resulted in a Good-Fair bioclassification indicating water quality may have improved in this reach. Future sampling at this station is recommended to assess further declines or improvements in water quality in this Cane Creek catchment. Based on the 2021 Good-Fair rating, this section of Cane Creek will likely be delisted as part of the 2024 IR assessment unless some additional data determines otherwise. The 2024 IR data window is 2018-2022.

Cane Creek (Cane Creek Reservoir) [AU# 16-27-(2.5)b1, 16-27-(2.5)b2 and 16-27-(2.5)b3; WS-II; HQW; NSW; CA] from the UT 0.5 miles downstream of SR1114 to the dam at Cane Creek Reservoir is currently (2022 IR) listed as data inconclusive. Cane Creek Reservoir is a water supply reservoir for the City of Chapel Hill. The reservoir was sampled five times from May through September 2018. The reservoir exhibited hypereutrophic conditions (excessive biological productivity) in the month of May with chlorophyll *a* concentrations ranging between 71 and 100 µg/L and relatively shallow Secchi depth readings (between 0.5 and 0.7 meters). The reservoir received an overall summer 2018 trophic classification of eutrophic based on the NCTSI scores (Figure 6-67) (DWR 2018 ISU Lakes Report). There is an EPA approved TMDL (September 2010) for Cane Creek Reservoir and is subject to the associated nutrient reductions required by the 2007 Jordan Lake Haw River arm TMDL load reduction targets of 8% TN and 5% TP. It is important to implement these reductions in order to see improvements in the water quality of this water supply reservoir.

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*In 2023, the DWR Intensive Survey Branch (ISB) conducted a special study alongside their Ambient Lakes Monitoring Program to characterize the presence and concentrations of PFAS Compounds in public drinking water supply reservoirs of the Cape Fear River Basin. The Cane Creek Reservoir consistently had the highest total quantifiable PFAS concentrations of all the reservoirs monitored in the basin. The direct source of the high PFAS concentrations are unknown at this time.*

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*There are no direct point source discharges in the Cane Creek subwatershed. There are however many dedicated residual land application fields receiving municipal biosolids which could be a source of PFAS compounds. Based on the results of this study, a special study in the Cane Creek Reservoir is recommended. This watershed is a good candidate for studying the fate and transport of PFAS between biosolid application fields, groundwater and drinking water supplies. For specific details of this study and the Cane Creek Reservoir results, see Chapter 12, section 12.4.1.6 (2023 Study of Emerging Compounds in Cape Fear River basin Reservoirs).*

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The lower 9-mile portion of Cane Creek [AU# 16-27-(7); WS-V; NSW] from the dam at Cane Creek Reservoir to the Haw River has not been assessed since a special benthic macroinvertebrate study in 1994 (Good/supporting rating). When resources allow, it is recommended that the biologists reassess Cane Creek (North side) station BB057 at Morrow Mill Rd for benthic macroinvertebrate community health.

Cane Creek (South side of Haw River) [AU# 16-28; WS-V; NSW] from source to Haw River has not been assessed since the late 1990s. This is a very rural watershed that traverses the lower portion of Alamance County flowing east to the Haw River. There appear to be chicken barns scattered throughout the watershed and a lot of residual land application fields. When resources allow, resample Cane Creek (South Side) watershed for benthic macroinvertebrate community health and to assess water quality to help with the understanding of impacts from a heavily agricultural watershed in the Haw River Subbasin.

#### 6.6.5.5 Collins Creek

Collins Creek was assessed for benthic macroinvertebrates in 2012 as part of a special study requested by USGS to determine the potential effects of 20 years of biosolids applications within the Collins Creek catchment. One sample, station BB522 [AU#16-30-(0.5)b, WS-V; NSW], was taken upstream of the biosolids application location. The other sample in this catchment, at station BB523 [AU#16-30-(0.5)b, WS-V; NSW], was taken downstream of the application area. The samples did not indicate any major differences among the two sample locations. The upstream station received a Poor bioclassification, while the downstream received a not rated due to very low-flow conditions. The data suggested that Collins Creek may suffer from organic pollution from upstream sources which may be exacerbated by low summer flows as well as fluctuations in dissolved oxygen and decreased habitat availability for benthic fauna. Only three EPT taxa were collected from Collins Creek above SR 1006 and four downstream at the Highway 54 station. Drought conditions in summer 2011 likely further stressed the Collins Creek catchment.



The lower portion of Collins Creek [AU# 16-30-(1.50; WS-IV; NSW] from a point 0.8 miles downstream of SR 1005/Old Greensboro Rd to Haw River is impaired (2022 IR) due to a Fair benthic macroinvertebrate rating at station BB310 (Table 6-40). This sampling station received a Fair benthic bioclassification in 2018. Despite the Fair benthic bioclassification, the EPTBI (3.96) was the lowest recorded from this station since sampling began here in 1986. This suggests a slightly more intolerant fauna present. Though water levels may drop during times of drought, there was ample evidence that flow was not interrupted here prior to collection.

BB522	
Year	Bioclassification
2012	Poor
BB523	
2012	Not Rated
BB310	
2009	Fair
2013	Not Rated
2018	Fair

Land development and agricultural practices continue to increase in the Collins Creek catchment. The special study conducted upstream from this location in 2012 found degraded stream conditions as far upstream as SR 1006. This study suggests organic pollution enters this catchment through various agricultural practices and coupled with extreme flow fluctuations known to occur in Slate Belt streams could exacerbate the observed reductions in stream EPT fauna. Collins Creek at this sampling station was Not Rated in 2013; due to heavy storms observed in mid-May 2013 prior to sampling likely leading to increased scour that may temporarily affect stream EPT richness.

Agricultural land use and development continue to increase in the Collins Creek catchment. Future sampling at this benthic basinwide station is recommended to assess any future declines or improvements in water quality in Collins Creek.

#### 6.6.5.6 Terrells Creek (South and North side of Haw River)

Terrells Creek (South side Haw River) [AU #16-31-(2.5); WS-IV; NSW] drains rural Chatham County and a small portion of southeastern Alamance County. There are two biological sampling stations located on Terrells Creek, benthic community station BB158 and fish community station BF9, which are co-located approximately 3.1 miles above the creek's confluence with the Haw River and 2.2 miles upstream from the Baldwin Mill Pond Dam, built circa 1820. There are no NPDES dischargers or municipalities within the watershed. Since 1992, forested land has decreased from 67% to 56% and developed land has increased from < 1% to 3%. Instream habitats are typical of high-quality Carolina Slate Belt-type habitats, with shallow and frequent riffles and runs, *Fissidens* (river moss), boulder pools, snags, root mats and undercuts and slick rocks.



Terrells Creek (South side Haw River) is impaired due to a Fair benthic macroinvertebrate rating at station BB158 (Table 6-40). This stream's biological community, sampled at station BB158, received a Fair benthic bioclassification in 2018 using the EPT sampling method. EPT richness (EPTS = 13, corrected richness = 11) was higher than observed in 2013 when it rated Poor. The seasonally corrected EPTBI was 3.52 and suggested a more intolerant benthic fauna than in previous sampling years. Future sampling at this location is recommended to assess water quality improvements or declines in Terrells Creek.

The Poor benthic bioclassification in 2013 could have been the result of extremely dry conditions followed by several heavy storm events scouring out the stream. Overall, despite the Fair benthic bioclassification, the 2018 sample suggested slight improvements in water quality compared to that observed in 2013 when it rated Poor.

Previous Terrells Creek basinwide benthic samples indicate this creek exhibits variations in flow regimes based on season and annual rainfall. Benthic data collected from this location since 1993 suggest stream flow likely slows or ceases annually. Based on USGS hydrographs, there was an obvious dry period in other nearby Cape Fear basin tributaries in December 2012 and January 2013 that may have negatively affected the benthic fauna, especially in smaller tributaries within the Carolina Slate Belt during the 2013 sampling events.

Fish community site BF9 was noted as having wide, forested riparian zones and no change in habitats between sampling cycles. Specific conductance at the site has been relatively stable since 1994, ranging from 73  $\mu\text{S}/\text{cm}$  in 2003 to 101  $\mu\text{S}/\text{cm}$  in 2013. As in cycles past, biologists noted lower than expected total fish species diversity at site BF9; intolerant species and piscivores were absent. Twenty-three fish species are known from this site including six species of sunfish and this site has rated Good five of the eight times it has been sampled.

These biology stations are affected by low flows and droughts as are many Carolina Slate Belt streams. However, they are also affected by the downstream impoundment which limits recolonization by stream fauna. Drought recovery studies conducted in 2008 were summarized in BAU Memorandum F-20090122.

*6.6.5.7 Terrells Creek/Ferrels Creek (North side Haw River)*

Terrells Creek/Ferrels Creek [AU #16-32; WS-IV; NSW] drains northern Chatham and southern Orange counties and is impaired (2022 IR) from source to Haw River due to a Fair benthic macroinvertebrate rating at station BB488 near River Rd taken in 2012 (Table 6-40). Potential causes of this low benthos rating may be suboptimal instream habitats (i.e., dominated by sandy runs), or potential drought or scour conditions prior to sampling. A co-located fish community station, BF43, received a Good-Fair rating in 2018. The sites are about 0.5 miles upstream of the creek's confluence with the Haw River. Although located within the Carolina Slate Belt, the site exhibits mostly Triassic basin instream characteristics. Wide intact forested riparian buffers on both sides of the stream provide good shading. Instream habitats are primarily sandy, bouldery runs with good pools and a few small riffles. There is a section of the left bank in the upper part of the reach

BB158	
Year	Bioclassification
2008	Fair*
2009	Good-Fair*
2009	Good-Fair
2013	Poor
2018	Fair
BF9	
2003	Excellent
3/13/2008	Good-Fair
4/17/2008	Good
5/15/2008	Good-Fair
6/12/2008	Good
2013	Good
*Special Study	



with severe vertical scouring and erosion from high flows. In 2018, the fish community had good diversity and abundance, although there were three less species collected compared to the 2013 sample. The community was trophically imbalanced in 2018 with 100% insectivores and as expected, no intolerant species. Overall, there was a six-point drop in the NCIBI score since the last survey, resulting in a rating decline to Good-Fair. The flux of species since 2013 (five gains and eight losses) is at least partly due to the proximity of the Haw River confluence, allowing for movements of fish in and out of the watershed. However, water quality parameters have remained relatively consistent at this location for over 20 years.

BB488	
Year	Bioclassification
2012	Fair*
BF43	
2003	Good
3/13/2008	Fair
5/15/2008	Excellent
2013	Good
2018	Good-Fair
*Special Study	

#### 6.6.5.8 Haw River Mainstem

Haw River [Cane Creek watershed (HUC 0303000205) portion of AU# 16-(10.5)e, WS-V, NSW; and 16-(28.5), WS-IV, NSW] from the confluence with Big Alamance Creek near Swepsonville to the confluence with Terrells Creek (Ferrells Creek/North side of Haw River) is an approximately 19-mile stretch of river that flows through Saxapahaw. There are two ambient stations and two benthic macroinvertebrate stations currently used to assess this segment of the Haw River mainstem (Table 6-36). There are two minor WWTPs that discharge directly to this segment of the Haw River mainstem near Saxapahaw.

Ambient station B1980000 captures the influence from the Big Alamance Creek watershed as well as the two smaller watersheds of Haw Creek and Varnals Creek and is located about 0.25 miles downstream of the dam in Saxapahaw. This station has limited nutrient data available (2000-2003). Ambient station B2000000, about 4.5 miles downstream, captures the Marys Creek and Cane Creek watershed drainages. There are no USGS flow gages on the mainstem Haw River in this HUC 10 watershed. Both ambient stations are located in the Haw River AU# 16-(10)e segment [from Hwy 49 to a point 0.4 miles downstream of Cane Creek (South side of Haw River)] and this segment is not rated for fecal coliform bacteria and turbidity due to elevated concentrations of these two parameters (2022 IR). The 2022 IR five-year mean concentrations (Table 6-27) for fecal coliform bacteria (761 and 851 cfu/100 ml) and turbidity (23 and 21 NTU) for B1980000 and B2000000, respectively, are very similar to the upstream concentrations where TMDLs are being implemented (see B1140000). The 2022 IR percent exceedance of the standard for turbidity were 9.6% and 8.3% and for fecal coliform bacteria were 21% and 23% for B1980000 and B2000000, respectively. The Cane Creek-Haw River HUC-10 subwatershed (0303000205) had the second highest turbidity concentration (23.6 NTU) of all the HUC-10 subwatersheds in the Haw River Subbasin, behind the Jordan Lake-Hew Hope HUC-10 level (0303000206) of 26.63 NTU (Table 6-10).

The section of the Haw River upstream and downstream of the dam at Saxapahaw is used for recreational purposes as there are paddling access points, campgrounds and parks. There have been algal blooms reported behind the dam. Four percent of the pH records at station B1980000 were elevated above the standard of 9 during the 2022 IR period, indicating that algal blooms were likely occurring upstream of the station. The elevated pH conditions occurred during the growing season. When resources allow, a special study assessing the water quality conditions in the Haw River behind the dam at Saxapahaw during the growing season is recommended since this section is frequently used for recreational purposes. Reducing nutrients, sedimentation and bacteria are needed to improve and protect the conditions of the Haw River. Implementation measures known to reduce loading of nutrients, bacteria and sedimentation should be applied throughout the Cane Creek – Haw River watershed (0303000205).

Overall, nutrient concentrations are elevated, however generally lower in this segment of the Haw River as the five-year mean TN and TP concentrations were 2.12 mg/L and 0.11 mg/L, respectively, at B2000000, compared to 2.82 mg/L and 0.16 mg/L at the upstream station B1200000 (*Table 6-27*). The total nitrogen concentration has not changed much over the last 20 years (*Figure 6-83*). The inorganic nitrogen (NOx) concentration was lower, and the organic fraction (as TKN) higher in 2018 and 2019, likely due to the higher flows in the Haw River system in those two years (*Figure 6-84*). This is also the time frame that many of the wastewater treatment plants began to meet their Jordan Lake TN permit limits resulting in a lower NOx load to the system. There was a decline in the TP concentration between 2000-2019 (seasonal Mann-Kendall trend calculated at 95% confidence) (*Figure 6-83* and *Table 6-24*). The Cane Creek-Haw River HUC-10 subwatershed had the highest mean TKN concentration (0.89 mg/L) which is based on a single station since no nutrient data was collected during the 2022 IR period at B1980000 (*Table 6-10*).

*It is recommended that, when resources allow, DWR should add nutrient monitoring at Haw River station B1980000.* It should be determined if this station would be appropriate for the collection of chlorophyll *a* monitoring, at least during the growing season. The stream geomorphology and resulting hydraulics may not be conducive to bloom formation but could potentially capture blooms that are occurring upstream in the pool behind the run of river dam at Saxapahaw. The elevated pH records at B198000 indicate that the impacts from possible blooms are being transported downstream.

Benthic community site BB220, Haw River at SR 1005 (E Greensboro Chapel Hill Rd), is co-located with ambient station B2000000 and was last sampled in 2008. Sampling in 2008 resulted in an increase in the bioclassification from the historically consistent rating of Good-Fair to Good indicating a slight increase in water quality. Water levels were down from previous years and habitat score increased from a low of 56 in 1998 to the current score of 72. Also, siltation is a chronic problem in areas of slow flow and pools of this river.



Due to restricted access and absence of riffle habitats at site BB220, the station was moved approximately six miles downstream after the 2008 sampling season to SR 1545 (Chicken Bridge Rd) and was given a new station name of BB529. Field measurements of specific conductance at both BB220 and BB529 have remained above 300  $\mu\text{S}/\text{cm}$  since 1998. Upstream dischargers contribute to the elevated specific conductance of the waters particularly in times of reduced flow. Thirty EPT were collected in 2013 and 28 EPT were collected in 2018 at this sampling station. Many of the small tributaries flowing into this stretch of the Haw River have mostly forested catchments and this may promote dilution of upstream point and nonpoint source pollutants and help to maintain some pollution intolerant macroinvertebrates. The 2013 and 2018 sampling events both resulted in Good bioclassifications similar quantities of taxa richness and EPT intolerant taxa were collected during each event.

BB220	
Year	Bioclassification
2008	Good
BB529	
Year	Bioclassification
2013	Good
2018	Good

The Haw River [AU# 16-(28.5), WS-IV, NSW] from a point 0.4 miles downstream of Cane Creek (South side) to a point 0.5 miles upstream of the Town of Pittsboro water supply intake in the Robeson Creek – Haw River 0303000207 HUC is listed as supporting on the 2022 IR due to the Good benthic macroinvertebrate rating in 2018 at site BB529 (Table 6-24). The remainder of the Haw River flows through the Robeson Creek-Haw River HUC 0303000207 portion of the watershed.

Implementation measures to address elevated turbidity and fecal coliform bacteria are needed throughout the Haw River watershed to address this water quality concern.

Figure 6-83: Five-Year Average Turbidity, Fecal Coliform Bacteria, Total Phosphorus, Total Nitrogen, Nitrate Nitrogen and Total Kjeldahl Nitrogen Concentrations in the Mainstem Haw River in HUC 0303000205 and 0303000207 Plus Robeson Creek Station B2450000 with Stream Flow at Haw River at Haw River USGS Gage Station 02096500.

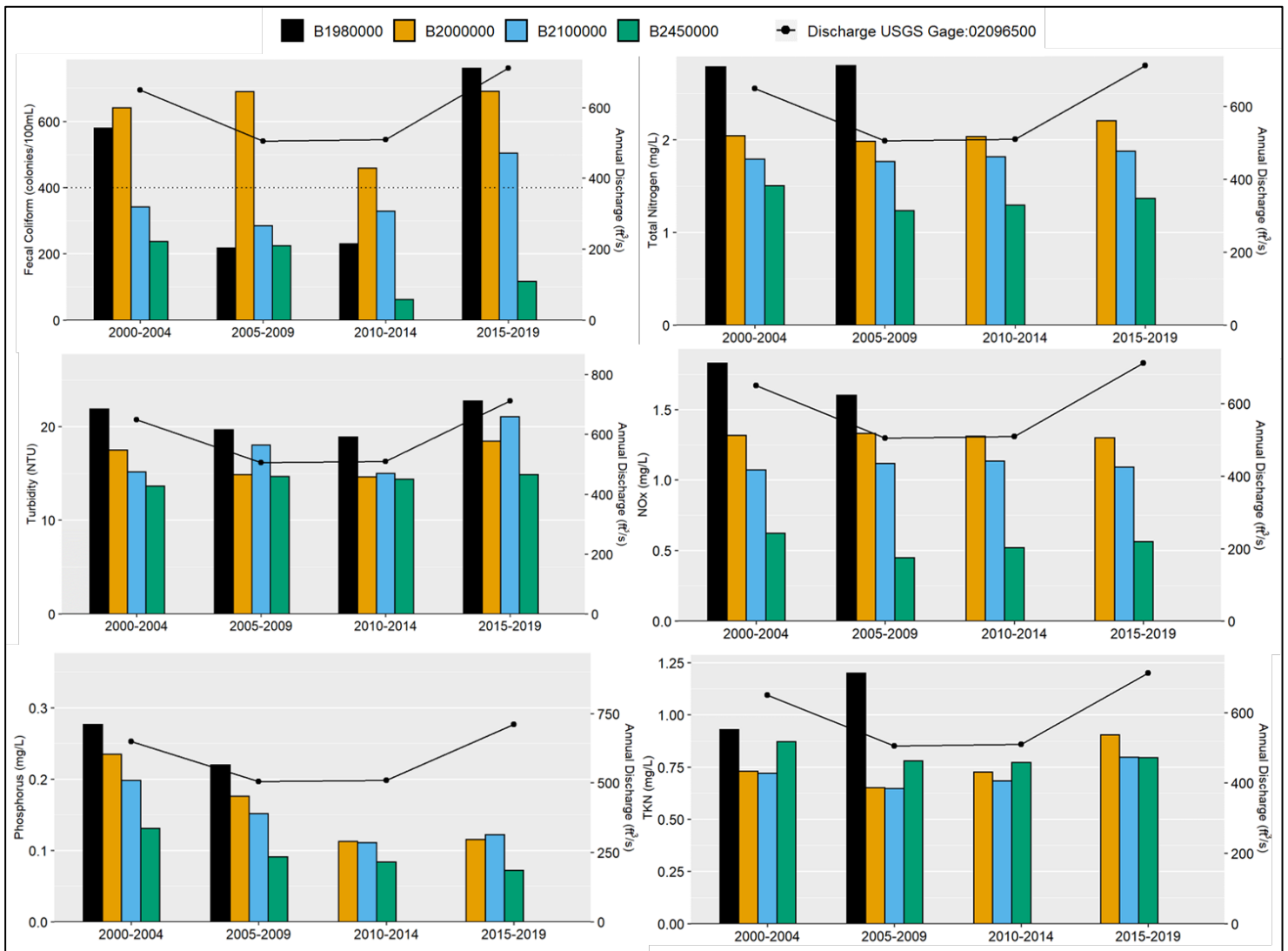
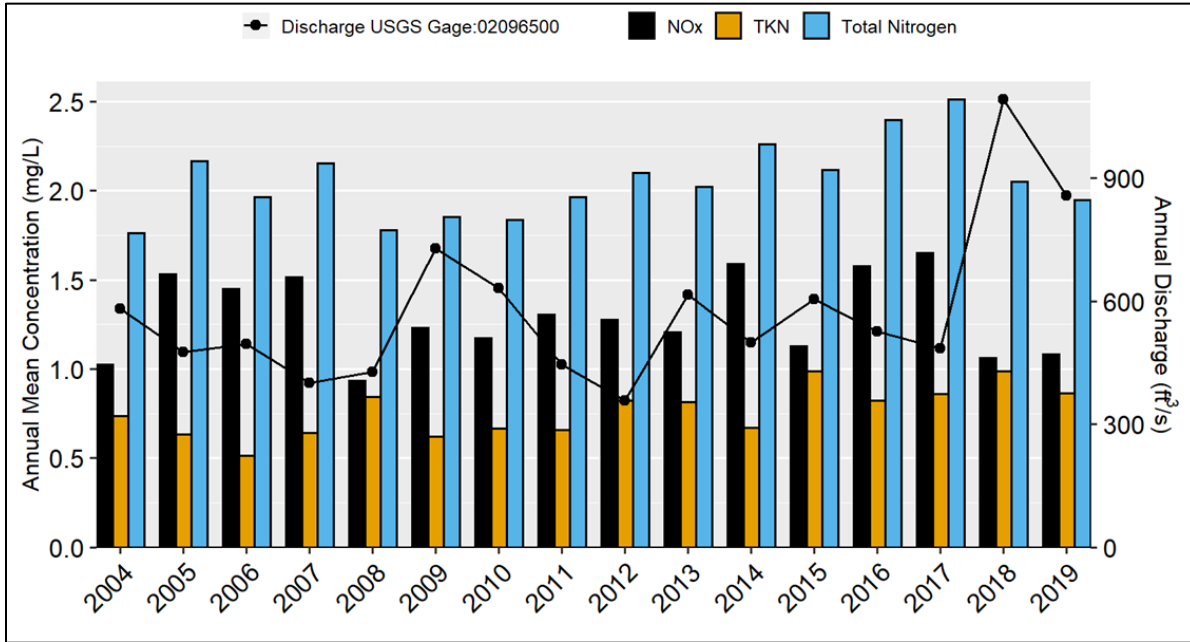


Figure 6-84: Haw River Nitrogen Constituent Concentration at Station B2000000 between 2004 and 2019.



6.6.5.9 Cane Creek – Haw River Watershed Summary

Best management practices to address nutrients, fecal coliform bacteria, turbidity/sedimentation and volume control are necessary to improve water quality throughout the Cane Creek-Haw River watershed.

The Cane Creek portion of the mainstem Haw River is an approximately 19-mile stretch of river that flows through Saxapahaw. The water quality data indicate that this section of the Haw River and its tributaries are impacted by elevated levels of turbidity/sedimentation and bacteria, similar to those segments upstream. There is an indication that there could be higher levels of biological productivity in the backwaters behind the dam on the Haw River in Saxapahaw.

There is a TMDL to address nutrient runoff to the Cane Creek Reservoir which requires nutrient load reductions from all sources in the watershed. Residual land application fields are of concern and a potential source of nutrients and emerging contaminants.

The 2022 IR impairment in this HUC-10 are all related to insufficient macroinvertebrate community structure and health due to water quality and habitat conditions. Efforts need to be made to protect streams from excess runoff resulting in stream scour and stream bank destabilization. The biologists suggested that organic pollution entering the streams through various agricultural practices, coupled with extreme flow fluctuations known to occur in Slate Belt streams could exacerbate the observed reductions in stream EPT fauna. The Cane Creek subwatershed is a rural, agriculture-rich watershed. It is located near the new poultry processing plant operated by Mountaire Farms in Siler City. Based on satellite imagery, animal agriculture has increased throughout the watershed. Because of its proximity to the poultry processing plant, these operations are likely poultry operations with dry litter waste management

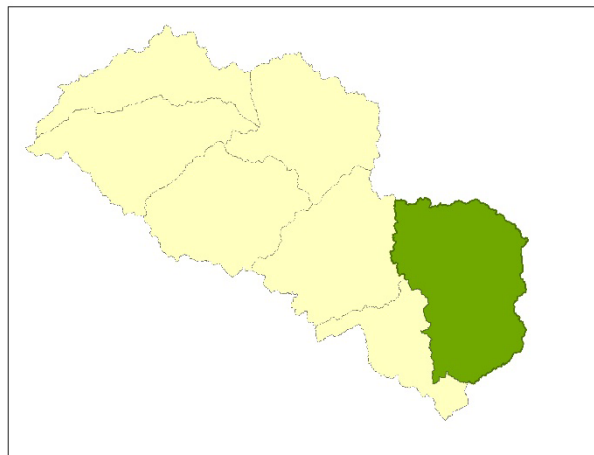
systems. These operations are deemed permitted under current rules and statutes and very little is known about where the poultry waste is land applied, how it is managed, or its potential impacts on water quality. Excess nutrients and bacteria are often associated with nonpoint source pollution from animal operations. BMPs that can slow or prevent runoff from entering a waterbody are recommended and encouraged to reduce the amount of nutrients leaving the fields where animal (or human) waste is land applied.

Additional watershed recommendations include:

- When resources allow, DWR should add nutrient monitoring at station B1980000 and consider, if appropriate, monitoring for chlorophyll *a* as well.
- When resources allow, DWR-ISB should conduct a special study assessing the water quality conditions in the Haw River behind the dam at Saxapahaw. Potentially add a site as part of the next ALMS basinwide assessment in 2028, if a study cannot be completed beforehand. There are a lot of recreational activities in this area and algal blooms are likely occurring during low-flow periods.
- When resources allow, DWR biologists should reassess several of the tributaries in this watershed for benthic macroinvertebrate health.
- Work with stakeholders to implement BMPs to address sources of sediment, nutrients, bacteria and runoff volume which is leading to scouring of stream banks and habitat decline.
- Biologists have noted an increase in organic material in the streams. When resources allow, additional monitoring or a special study should be conducted to identify the organic sources in the watershed. Potential sources include animal and human waste application and stormwater runoff from agricultural operations and natural areas.

#### 6.6.6 B. Everett Jordan Lake – New Hope Creek Watershed (0303000206)

The Jordan Lake – New Hope Creek watershed includes the majority of Jordan Lake referred to as the New Hope River Arm of Jordan Lake and the creeks and streams that drain to this section of the lake. This watershed is the largest in the Haw River subbasin, spanning 343 square miles and parts of Durham, Orange, Wake and Chatham counties. The lowest portion of the lake, along the Haw River mainstem and several streams that drain to that are located in the adjacent Robeson Creek watershed (0303000207) discussed in the next section. This watershed overlies the geology of the Triassic basin, with all but the largest streams having regular very low-flow periods. New Hope, Little, Northeast, Morgan and Third Fork creeks drain to the upper section of Jordan Lake where Chapel Hill, Durham and Morrisville are located. The middle and lower sections of the lake located in this watershed receive drainage from White Oak and Beaver creeks where the western Wake County suburbs Cary and Apex are located. The Jordan Lake – New Hope Creek watershed is in a rapidly urbanizing region that accounted for over half of the population growth from 2010 to 2020 in the Haw River, an increase of more than 84,000 (*Table 6-4*). The overall 2020 population was estimated to be about 379,000 people in this watershed. In 2019, more than a third, 34.4%, of the watershed was developed and 47% was forested (*Table 6-5*).



As of 2022 there are 12 minor and three major NPDES wastewater discharge facilities and 158 single-family NPDES permits with a combined as-built discharge of 51.390865 MGD (51.3466 for major and minor facilities and 0.044265 MGD (44,265 gallons/day) for single-family). The major NPDES facilities include the Orange Water and Sewer Authority Mason Farm WWTP (NC0025241), permitted to discharge 14.5 MGD to Morgan Creek; Triangle WWTP (NC0026051) permitted to discharge 12.0 MGD to Northeast Creek; and the South Durham WRF (NC0047597) with a permitted discharge of 20 MGD to New Hope Creek. Other permits in this watershed include one animal individual state AFO permit and 43 NPDES and 13 state stormwater facilities. There are also 698 acres of wastewater irrigation, reclaimed water and residual solids land application fields in this watershed. Several facilities are associated with the 128.6 acres of wastewater irrigation, including two state facilities, Jordan Lake State Recreational Area (SRA) - Parkers Creek WWTF (WQ0002665) and Jordan Lake SRA - Poplar Point WWTF (WQ0004122), which accounted for over fifty acres. There are also 162 individual permitted wastewater irrigation fields for single-family dwellings ranging in size from 0.2 to 0.7 acres that collectively are about 52 acres total. Aqua North Carolina has several facilities associated with reclaimed water field application, including the Governors Club WWTP (WQ0000088) for 195.6 acres, the Preserve at Jordan Lake WWTP (WQ0018146) for 137.5 acres, the Legacy at Jordan Lake WWTP (WQ0024844) for 97.7 acres, the Westfall WWTP (WQ0028798) for 38.9 acres, and the Colvard Farms WWTP (WQ0019569) for 19.3 acres. The Orange Water and Sewer Authority (WQ0001169) has 53.8 acres of permitted residual solids land application fields in this watershed.

In 2022, Jordan Lake was impaired for chlorophyll *a*, turbidity and pH with a TMDL ([Table 6-42](#)). Turbidity entering the lake through the New Hope Creek Arm and lower Haw Creek section is visible on satellite imagery ([Figure 6-85](#)). Several of the creeks (New Hope, Little, Morgan, Booker, Third Fork, Panther, Bolin and Northeast Creek) that drain to the upper portion of Jordan Lake have impairments and are not meeting water quality standards. These impairments include benthos, fecal coliform bacteria, dissolved oxygen, total and dissolved copper, total zinc and turbidity ([Table 6-42](#)). Several of these impairments have TMDLs ([Table 6-12](#)). University Lake, located along Morgan Creek, is also impaired for chlorophyll *a* and has an EPA approved TMDL (2010 [Morgan Creek TMDL](#) is a part of an addendum to the 2007 Jordan Lake TMDL). There is a Jordan Lake/Haw River watershed-wide nutrient management strategy to address excess nitrogen and phosphorus to Jordan Lake and also applies to the smaller reservoirs in the watershed (see details of the strategy below in section [6.6.6.9](#)). Actions taken to improve water quality in Jordan Lake will result in improved local water quality conditions throughout the entire watershed.

For this assessment (2002-2020) of the watershed draining to the lake, there were nine ambient instream monitoring stations (one AMS, four UCFRBA coalition and four co-located), three RAMS stations, 12 benthic macroinvertebrate (including both basin and special study sites) and four fish community stations used to assess the water quality conditions over this time period (not including nine lake ambient stations) ([Figure 6-13](#), [Figure 6-16](#), and [Table 6-43](#)). There was also another special study benthos station in 2021. Four of the nine regular ambient stations are co-located between DWR-AMS and UCFRBA and the co-located station B3040000 on New Hope Creek was replaced by B30390000 in October 2019 due to sampling safety concerns. Ambient ([Table 6-43](#)) and biology stations discussed in this section were used in the 2022 IR, a complete list of all 2002 to 2020 stations is located in the Chapter 2 Appendix. The Jordan Lake subwatershed (0303000206) has the highest overall mean (2016-2020) for

conductivity, turbidity and total suspended solids in comparison to the others in the Haw River subbasin (Table 6-10).

Table 6-42: New Hope Creek/ B Everett Jordan Lake 0303000206 Watershed 2022 IR Use Support Summary.

Stream & AU	Stream Class + NSW	~Stream Length (Miles or Acres)	Description	Ambient or Lakes Station	Biological Station	Parameter of Concern & 2022 IR Rating/Category
New Hope Creek 16-41-1-(0.5)a	WS-V	17.5	From Source to Sand Creek		BB324	Supporting/ Meeting Criteria
New Hope Creek 16-41-1-(0.5)b	WS-V	0.70	From Sandy Cr. to a point 0.3 miles upstream of Durham Co SR 2220			No Data
New Hope Creek 16-41-1-(11.5)a	WS-IV	0.4	From a point 0.3 miles upstream of Durham Co. SR 2220 to SR 2220		BB090 BF57	5- Benthos
New Hope Creek 16-41-1-(11.5)b	WS-IV	3.5	From SR2220 to I-40	B3020000	BB90	5- Benthos 4c- DO 3a- Turbidity 3a – Fecal CB
New Hope Creek 16-41-1-(11.5)c	WS-IV	4.0	From I-40 to a point 0.8 miles downstream of Durham Co. SR 1107 (Stagecoach Rd)	B3039000 B3040000	BB238 BF57	4c – Benthos 3a – Fecal CB 3a – 1,4-Dioxane
Third Fork Creek 16-41-1-12-(1)	WS-V	5.16	From Source to a point 2.0 miles upstream of NC Hwy 54	RAMS B2970000 (2007-2008 & 2015-2018)		5 – Benthos 3a – DO 3a – Copper (dissolved Chronic)
Third Fork Creek 16-41-1-12-(2)	WS-V	3.86	From a point 2.0 miles upstream of NC Hwy 54 to New Hope Cr	B3025000	BB460 BF116	5 – Benthos 5 – Copper (total) 4t – TSS 3i – Turbidity 3a – Fecal CB
Bolin Creek (Hogan Lake) 16-41-1-15-1-(0.5)a	WS-V	5.3	From source to Pathway Dr.		BB330 BF47	Supporting/ Meeting Criteria
Bolin Creek (Hogan Lake) 16-41-1-15-1-(0.5)b	WS-V	3.10	From Pathway Dr. to US Hwy 501 Business		BB506 BB62 BB449 BB071 BF8	5 - Benthos
Bolin Creek 16-41-1-15-1-(4)	WS-IV	0.91	From US Hwy 501 Business to Little Creek		BB071 BF14	5 - Benthos
Booker Creek (Eastwood Lake) 16-41-1-15-2-(1)	WS-V	3.5	From Source to dam at Eastwood Lake.	RAMS B3050000 (2007-2008)	BB493 BB198	5 – Benthos 5 – DO
Booker Creek 16-41-1-15-2-(4)	WS-V	1.22	From dam at Eastwood Lake to US Hwy 15		BB450	5 – Benthos
Little Creek 16-41-1-15-(0.5)	WS-IV	4.93	From confluence of Booker and Bolin to Durham Co. SR 1110		BB197	5 - Benthos

Stream & AU	Stream Class + NSW	~Stream Length (Miles or Acres)	Description	Ambient or Lakes Station	Biological Station	Parameter of Concern & 2022 IR Rating/Category
Little Creek 16-41-1-15-(3)	WS-IV CA	0.80	From to Durham Co. SR 1110 to New Hope Creek Arm of Jordan Lake.			No Data
Morgan Creek 16-41-2-(1)	WS-II HQW	7.1	From source to a point 1.4 miles downstream of NC Hwy 54		BB146	Supporting/ Meeting Criteria
Morgan Creek 16-41-2-(1.5)	WS-II CA HQW	163.3 acres	From a point 1.4 miles downstream of NC Hwy 54 to dam at University Lake	CPFUL4 CPFUL6		4t – TN 4t – TP 4i – Chl a
Morgan Creek 16-41-2-(5)	WS-V	1.64	From dam at University Lake to Orange Co SR 1919			No Data
Morgan Creek 16-41-2-(5.5)a	WS-IV	4.05	From Orange Co SR 1919 to confluence with Meeting of the Waters (creek)	B3899180		3a – Fecal CB
Morgan Creek 16-41-2-(5.5)b	WS-IV	4.10	From Meeting of the Waters (creek) to Chatham Co SR 1726	B3900000	BB53 BB96 BF15	5 – Benthos 5 - Fish
Northeast Creek 16-41-1-17-(0.3)	WS-V	5.55	From source to NC Hwy 55			No Data
Northeast Creek 16-41-1-17-(0.7)a	WS-IV	3.27	From US Hwy 55 to Durham Triangle WWTP	B3300000	BF108	5 – Turbidity 5 – Copper total 4t – Fecal CB 3c - DO
Northeast Creek 16-41-1-17-(0.7)b1	WS-IV	3.3	From Durham WWTP to Kit Creek	B3660000		5 – Turbidity 5 – Zinc total 4t – Fecal CB
Northeast Creek 16-41-1-17-(0.7)b2	WS-IV	3.2	From Kit Creek to a point 0.5 miles downstream of Panther Creek	B3670000		5 – Turbidity 5 – Copper total 5 – Zinc total 4t – Fecal CB
Northeast Creek 16-41-1-17-(4)	WS-IV CA	1.24	From a point 0.5 miles downstream of Panther Creek to New Hope Creek Arm of Jordan Lake			No Data
Panther Creek 16-41-1-17-3	WS-IV	5.65	From source to New Hope Creek Arm of Jordan Lake	RAMS B3670500 (2017-2018)		5 – Copper dissolved 3a – DO
New Hope Cr. Arm of Jordan Lake 16-41-1-(14)	WS-IV; CA	1,415.9 acres	From a point 0.8 miles downstream from Durham Co. SR 1107 to confluence with Morgan Cr. Arm of Jordan Lake	CPF081A1C CPF081A1B		4i – Chl a, 4i - Turbidity 4i - pH 4t – TN 4t – TP 4t - TSS
Morgan Creek Arm of Jordan Lake 16-41-2-(9.5)	WS-IV CA	836 acres	From Chatham Co SR 1726 to New Hope Creek Arm of Jordan Lake	CPF086C CPF086CUPS CPFMC03 CPFMC03 CPFMC04		4i – Chl a 4i – Turbidity 4t – TN 4t – TP 4t - TSS 3a - pH

Stream & AU	Stream Class + NSW	~Stream Length (Miles or Acres)	Description	Ambient or Lakes Station	Biological Station	Parameter of Concern & 2022 IR Rating/Category
New Hope River Arm of Jordan Lake 16-41-(0.5)	WS-IV CA B	1,200 acres	From confluence of Morgan Creek and New Hope Cree Arms of Jordan Lake to Chatham County SR 1008 (Farrington Rd.)	CPF086D CPF086F		4t – TN 4t – TP 4i – Chl a
New Hope River Arm of Jordan Lake 16-41-(3.5)a1	WS-IV CA B	2,235 acres	From Chatham County SR 1008 to White Oak Creek Arm	CPF086G CPF087B3		4t – TN 4t – TP 4i – Chl a
New Hope River Arm of Jordan Lake 16-41-(3.5)a2	WS-IV CA B	337 acres	From White Oak Creek Arm to US 64	CPF087D		4t – TN 4t – TP 4i – Chl a 3a - Turbidity
New Hope River Arm of Jordan Lake 16-41-(3.5)a3	WS-IV CA B	3,102 acres	From US 64 to Haw River Arm of Jordan Lake.	CPF0880A		4t – TN 4t – TP 4i – Chl a 3i – pH (9)
New Hope River Arm of Jordan Lake 16-41-(3.5)b	WS-IV CA B	821 acres	White Oak Creek Arm of Jordan Lake			No Data
New Hope River Arm of Jordan Lake 16-41-(3.5)c	WS-IV CA B	542 acres	Parkers Creek Arm of Jordan Lake			No Data
New Hope River Arm of Jordan Lake 16-41-(3.5)d	WS-IV CA B	1,260 acres	Beaver Creek Arm of Jordan Lake			No Data

IR Categories: (Add link to categories)

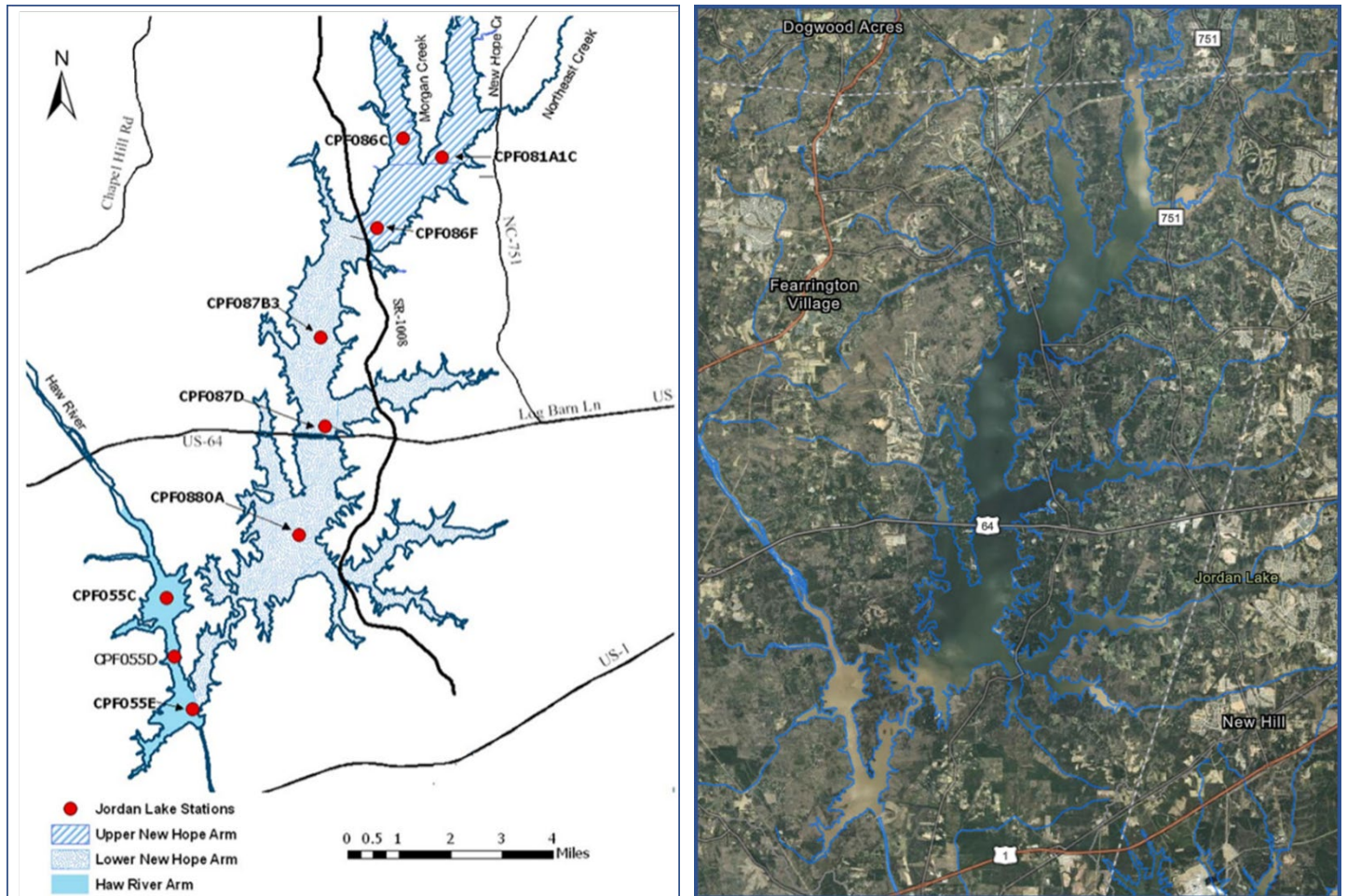
There are also many Jordan in-Lake monitoring stations that have been monitored over this time period. There are nine main lake stations that are monitored on a regular basis by ISB ALMP, three in each of the three lake management arms, Upper New Hope (CPF086C, CPF081A1C, CPF086F), Lower New Hope (CPF087B3, CPF087D, CPF0880A) and the Haw River (CPF055C, CPF055D, CPF055E), with the latter discussed in detail in the Robeson Creek watershed section (*Figure 6-85*). The overall 2022 IR use support is included in *Table 6-42*. The nutrient loading from all the tributaries draining to the lake impacts the algal productivity throughout Jordan Lake.

In 2018 and 2020-2023, while ISB was evaluating nutrient-related conditions in Jordan Lake Reservoir, additional samples were collected to monitor for the presence per- and poly-fluorinated alkyl substances (PFAS) as part of an initiative to provide baseline emerging compound data for public drinking water supply reservoirs in the Cape Fear River Basin.

The results from these studies demonstrated a widespread distribution of detectable PFAS in Jordan Lake, with about eight PFAS compounds consistently present throughout the lake. The Haw River arm of Jordan Lake generally had the highest overall detectable PFAS concentrations. Additional assessments are needed to understand the long-term persistence of these compounds in this system. It is important to note that all the analytical data identified in Jordan Lake reflect levels of target analytes detected in untreated surface waters, not levels found in finished drinking water.

The majority of the public water supply (PWS) facilities are taking part in the EPA Fifth Unregulated Contaminant Monitoring Rule (UCMR5) study, which requires PWS facilities to participate in monitoring for 29 different PFAS compounds in their finished drinking water. The results from these field studies are reported in detail in the PFAS Chapter of this plan (Chapter 12, Section 12.4.1).

Figure 6-85: Jordan Lake Primary Ambient Lake Monitoring Station Map with the Three Nutrient Management Lake Arms and an AGOL Satellite Image of the Same Area.



Development of the Jordan Lake Nutrient Management Strategy was a multi-year effort with extensive stakeholder involvement, dating back to lake modeling which began in the late 1990s. In 2008, the EMC adopted the Jordan Lake nutrient rules (Title 15A NCAC 02B .0263-.0273) which went into effect August 2009. From 2011 to 2018, while some Jordan rules were being implemented including buffer protection, a series of session laws delayed other rules or portions of rules and ultimately halted most stormwater implementation. They also required nutrient management research and modeling by the NC Policy Collaboratory, which was completed in December 2019. Detailed information on the lake TMDL, nutrient strategy rules and implementation as well as a timeline for Jordan Lake rules readoption is available below is section 6.6.6.9.

### 6.6.6.1 New Hope and Third Fork Creeks

The headwaters of New Hope Creek originate in the upper northwest corner of the Jordan Lake HUC 10 (0303000206) watershed in Orange County and flows in a southeasterly direction into Durham County and through the southwestern corner of the City of Durham. New Hope Creek becomes impaired or exceeding criteria for biology and low dissolved oxygen (*Table 6-42*) as it flows through the City of Durham. There are elevated levels of turbidity, fecal coliform bacteria and nutrients in New Hope Creek.

There are two ambient monitoring stations used to assess New Hope Creek and one for Third Fork Creek (*Table 6-43*). The City of Durham’s 20 MGD South Durham WRF (NC0047597) discharges into New Hope Creek between the ambient monitoring stations. Third Fork Creek also flows into New Hope Creek between the two water quality stations. The downstream station, B3040000 is used to assess the water quality of this system prior to entering the New Hope Creek Arm of Jordan Lake. Station B3040000 was moved from Stagecoach Road to station B3039000 (fewer than 500 feet upstream) in October 2019 due to sampling safety concerns. There is a USGS flow gage at Stagecoach Road as well (#0297314). The 2019 land use has not changed substantially at B3040000 since 2001, which captures most of the watershed entering the upper portion of the lake. Development increased from 41 to 44% with forest declining from 46 to 43%. The impervious cover in 2019 was estimated to be 12.7%, which was up from 10.5% in 2001.

*Table 6-43: B Everett Jordan Lake-New Hope River (0303000206) Ambient Monitoring Stations Collected by DWR and the Upper Cape Fear River Basin Association Monitoring Coalition.*

Station ID	Station Location	Monitoring Program*	County	Stream AU#	Stream Classification + NSW	HUC 12
B2970000	Third Fork Creek at NC 55 Durham	RAMS 2007-2008	Durham	16-41-1-12-(1)	WS-V	030300020602
B3020000	New Hope Creek at NC 54 near Durham	UCFRBA	Durham	16-41-1-(11.5)a	WS-IV	030300020604
B3025000	Third Fork Creek at NC 54 near Durham	AMS/UCFRBA	Durham	16-41-1-12-(2)	WS-IV	030300020602
B3039000	New Hope Creek at Concrete Impoundment (replaced B3040000)	AMS/UCFRBA	Durham	16-41-1-(11.5)c	WS-IV	030300020604
B3040000	New Hope Creek at Stagecoach Rd near Blands	AMS/UCFRBA	Durham	16-41-1-(11.5)c	WS-IV	030300020604
B3050000	Booker Creek at NC 86 Chapel Hill	RAMS 2007-2008	Orange	16-41-1-15-2-(1)	WS-V; B	030300020603
B3300000	Northeast Creek at Sedwick Rd near RTP	UCFRBA	Durham	16-41-1-17-(0.7)	WS-IV	030300020605
B3660000	Northeast Creek at SR 1100 near Nelson	AMS	Durham	16-41-1-17-(0.7)	WS-IV	030300020605
B3670000	Northeast Creek at O Kelly Church Rd. near Durham	UCFRBA	Chatham	16-41-1-17-(0.7)	WS-IV	030300020605
B3670500	UT Panther Creek off SR 3120 Cary	RAMS 2017-2018	Wake	16-41-1-17-3	WS-IV	030300020605
B3899180	Morgan Creek at Mason Farm WWTP entrance at Chapel Hill	UCFRBA	Orange	16-41-2-(5.5)a	WS-IV	030300020607

B3900000	Morgan Creek at Old Farrington Rd. near Farrington	AMS/UCFRBA	Chatham	16-41-2-(5.5)b	WS-IV	030300020607
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Monitoring Program\*: AMS = DWR Ambient Monitoring System; UCFRBA = Upper Cape Fear River Basin Association; RAMS=DWR Random Ambient Monitoring System with 2-Years of monitoring (See chapter 2 for more details on programs). Green highlighted stations no longer sampled.

As required by the Clean Water Act, the City of Durham has a NPDES Stormwater Permit (NCS000249) to discharge stormwater into streams. To ensure the city's compliance with their permit, they have developed a [Stormwater Division](#) which is divided into four groups and includes Development Review, Infrastructure, Stormwater Quality and Watershed Restoration groups. The Stormwater Quality group does their own water quality monitoring, illicit discharge detection and enforcement as well as public outreach. They have identified the top five sources of pollution in City of Durham's stream to be:

1. Public sanitary sewer discharge
2. Erosion and sediment discharge
3. Petroleum spills
4. Private sanitary sewer discharge
5. Improper yard waste disposal

The City of Durham's [Watershed Restoration group](#) have completed and implementing watershed improvement plans for [New Hope Creek and Little Creek Watershed](#) (2021) and [Third Fork Creek Watershed](#) (2012).

*Table 6-44: New Hope Creek Watershed Five-Year Mean Concentrations at Ambient Stations (2016-2020) with Seasonal/Non-seasonal Mann-Kendell Trends (Calculate at 95% Confidence).*

Parameter	TN# (mg/L)	NOx (mg/L)	TKN (mg/L)	NH3 (mg/L)	TP (mg/L)	Fecal C. (cfu/100 mL)	Turbidity (NTU)	Conductivity (µS/cm)	Station Trend* Information 2000-2019 & 2010-2019 Decreasing (↓) or Increasing (↑) Seasonal (S) or Non-Seasonal (NS)	Watershed Information
B3020000	0.83	0.15	0.68	0.03	0.06	821	25.89	135	NH3 - ↓ S 10-19; TP - ↓ S 00-19 & S 10-19	<b>New Hope Creek</b>
B3039000	3.94	2.91	1.03	0.10	0.15	515	20.4	280	New station 2019 & 2020 only; Replaced B3040000	<b>New Hope Creek</b> Downstream of Major WWTP (20 MGD)
B3040000	3.26	2.33	0.92	0.05	0.18	797	33.2	302	NH3 - ↓ S 00-19; TP - ↓ S 00-19; TKN - ↑ S 00-19; NOx - ↓ S 10-19	<b>New Hope Creek</b> Downstream of Major WWTP (20 MGD)
B3025000	0.94	0.20	0.74	0.04	0.12	1391	31.2	242	TP - ↓ S 00-19 & 10-19; NH3 - ↓ S 10-19	<b>Third Fork Creek</b>
B3300000	0.87	0.11	0.76	0.04	0.09	642	76.7	198	(Missing 2016-2019 data) Sampling Restarted 3/2020	<b>Northeast Creek</b>
B3660000	2.94	2.13	0.83	0.05	0.23	603	42.4	417	TP - ↓ S 00-19; NOx - ↓ S 00-19; TKN - ↓ S 00-19 & S 10-19; NH3 - ↓ S 00-19 & S 10-19; Fecal C - ↑ S 10-19 Turbidity - ↑ NS 10-19;	<b>Northeast Creek</b> Downstream of Major WWTP (12 MGD)

Parameter	TN# (mg/L)	NOx (mg/L)	TKN (mg/L)	NH3 (mg/L)	TP (mg/L)	Fecal C. (cfu/100 mL)	Turbidity (NTU)	Conductivity (µS/cm)	Station Trend* Information 2000-2019 & 2010-2019 Decreasing (↓) or Increasing (↑) Seasonal (S) or Non-Seasonal (NS)	Watershed Information
B3670000	2.5	1.50	0.99	0.07	0.23	557	42.8	354	TP - ↓ S 00-19; NH3 - ↓ S 10-19; Fecal C - ↑ S 00-19 Turbidity - ↑ S 10-19;	Northeast Creek Downstream of Major WWTP (12 MGD)
B3670500	0.89	0.20	0.69	0.03	0.07	NA	17.6	135	RAMS 2017-2018	Panther Creek
B3899180	0.98	0.41	0.57	0.02	0.05	844	15.9	153	NOx - ↓ S 10-19	Morgan Creek
B3900000	3.54	2.81	0.72	0.05	0.15	420	14.7	326	TP - ↓ S 00-19; NOx - ↓ S 00-19 & NS 10-19; TKN - ↓ NS 00-19; NH3 - ↓ NS 00-19 & S 10-19	Morgan Creek Downstream of Major WWTP (14.5 MGD)

# TN is calculated as NOx + TKN. Both values were required to develop a TN value.

\* DWR conducted a seasonal or nonseasonal Mann-Kendall trend test at most AMS stations that had sufficient data available; reporting only significant increasing or decreasing trends, calculated at 95% confidence from data collected from 2000-2019 and 2010-2019.

For Non-detects or records below the detection limit, the detect limit value is used in the overall summary means and half the detection limit for trends analysis.

New Hope Creek [AU# 16-41-1-(0.5)a] from the source to Sandy Creek is listed (2022 IR) as supporting or meeting all uses due to the 2003 benthic macroinvertebrate special study at BB324, which rated Good-Fair when it was sampled ([Table 6-42](#)).

About four miles of New Hope Creek [AU# 16-41-1-(11.5)a and 16-41-1-(11.5)b] from a point 0.3 miles upstream of Old Chapel Hill Rd to I-40 is listed as impaired due to an older benthic macroinvertebrate assessment at BB090 ([Table 6-42](#)), which was sampled in 1987. Site BB090 is co-located with fish community station BF57, which rated Good-Fair the one time it was sampled in 2003. This section of New Hope Creek is well buffered with good connection to the flood plain, however it likely received a lot of stormwater from the more densely urbanized area that surrounds this sample location. As time and resources allow, DWR should consider resampling BB090 to determine if the impairment persists.

BF57	
Year	Bioclassification
2003	Good-Fair

The water quality data from ambient monitoring station B3020000 located at Nelson Chapel Hill Hwy continues to show low dissolved oxygen issues with 16.7% (with 96% confidence) of the samples collected between 2016 and 2020 (2022 IR) below the instantaneous state standard of 4 mg/L and remains listed as impaired/exceeding criteria on the 2022 IR ([Table 6-42](#)). The mean and median DO concentrations for the 2022 IR period were 6.19 and 5.90 mg/L, respectively, with a minimum record of 1.70 mg/L. The instream DO concentration increased downstream at station B3040000 ([Figure 6-86](#)), with a 2022 IR mean concentration of 7.16 mg/L and fell below the standard only three percent of the time with a minimum recorded reading of 2.1 mg/L.

This section of New Hope Creek receives drainage from the 5.7-mile-long Sandy Creek which runs through Duke Campus. The City of Durham conducted a study to investigate pollutant sources in a section of Sandy

Creek (Tributary A) which has very low dissolved oxygen concentrations. To understand why this stream has such low dissolved oxygen the City of Durham monitored the water quality at different sites, assessed the stream condition, performed a thermal imaging survey and performed a microbial source tracking study. The City of Durham found that this section of the creek is impacted by high rates of stormwater runoff, low base flow, sewer leaks and groundwater with especially low dissolved oxygen entering the stream. The study concluded that this creek could benefit from stormwater control measures like stream restoration to widen the floodplain and enhanced riffle features. These measures would increase the amount of dissolved oxygen in the water, while regular monitoring of the stream for illicit discharges would help protect it from further degradation. Improving conditions in Sandy Creek will likely improve the water quality in New Hope Creek. For more information on the City of Durham’s Sandy Creek pollution source tracing study, see their May 2022 Sandy Creek PST Final Report on their study [website](#).

New Hope Creek [AU# 16-41-1-(11.5)c] from I-40 to a point 0.8 miles downstream of Stagecoach Road is listed as impaired (2022 IR) due to a Fair benthic macroinvertebrate rating at BB238 (Table 6-42), which was last sampled in 2008. This Triassic site is co-located with AMS station B3040000 and is below the City of Durham’s South Water Reclamation Facility. The reach was a long, slow-flowing run with no riffles or pools present. Banks were steep and eroding and instream habitat was limited to woody debris. Site BB238 has been consistently rated Fair; this site should be resampled as time and resources allow to determine if the impairment persists.

BB238	
Year	Bioclassification
2003	Fair
2008	Fair

Turbidity and fecal coliform bacteria concentrations are also elevated in New Hope Creek and resulted in data inconclusive ratings (3a) for much of the creek (Table 6-42 and Figure 6-86). The turbidity 2015-2019 five-year mean was higher at the downstream station B3040000 in the last five-year period, where it had been slightly higher previously at the upstream station B3020000 (Figure 6-86 and Table 6-44). The 2022 IR exceedance rate of the 50 NTU standard was 10.2% at B3020000 (upstream station) and 12.6% at B3040000 (downstream station). The five-year mean fecal coliform bacteria concentrations were very similar at the two stations for the 2015-2019 timeframe but generally higher at B3020000 (Figure 6-86). The 2022 IR mean concentrations were 821 and 797 cfu/100 for the two stations, respectively (Table 6-44). The replacement station, B3039000 had a lower mean of 515 cfu/100 mL which was from October 2019 to December 2021 only (Table 6-44).

To determine how flow impacts the instream water quality conditions, data was processed using a flow separated analysis and found that turbidity and fecal coliform bacteria concentrations are highly influenced by flow. The mean turbidity and fecal concentrations are substantially higher at the high flows ( $\geq 89.3$  cfs: 46.7 NTU and 1,733 cfu/100 ml, respectively) than at the middle flows (21.8 NTU and 314 cfu/100) or low flows ( $\leq 18.2$  cfs: 14.4 NTU and 156 cfu/100 mL) (Figure 6-87). Stormwater runoff from the landscape and stream bank erosion due to high flow rates are likely the main contributors to higher turbidity levels at high flows. Stormwater runoff, sanitary sewer overflows, leaky collection system as well as onsite single family wastewater systems are likely contributing to the higher bacteria concentrations. These results are similar to all of the stations assessed using the flow separated technique in the Haw River subbasin (Figure 6-17). There is a description of how this data is processed in section 6.3.

Between 2018 and 2023, two ambient water quality monitoring stations were monitored for 1,4-dioxane in New Hope Creek. All 14 samples collected between 2018 and 2019 at station B3040000 (Stagecoach Rd.) were below the PQL of 1 µg/L (non-detect). Of the 22 samples collected at replacement station B3039000 (October 2019 - April 2023), only one exceeded the PQL of 1 µg/L, with a concentration of 1.9 µg/L. For more information on emerging contaminants, see section 2.12 and chapters 12 (PFAS) and 13 (1,4-dioxane).

Figure 6-86: Five Year Average Dissolved Oxygen, Turbidity and Fecal Coliform Bacteria Concentrations at Stations B3020000 and B3040000 in New Hope Creek with Stream Flow at USGS Gage 02097314.

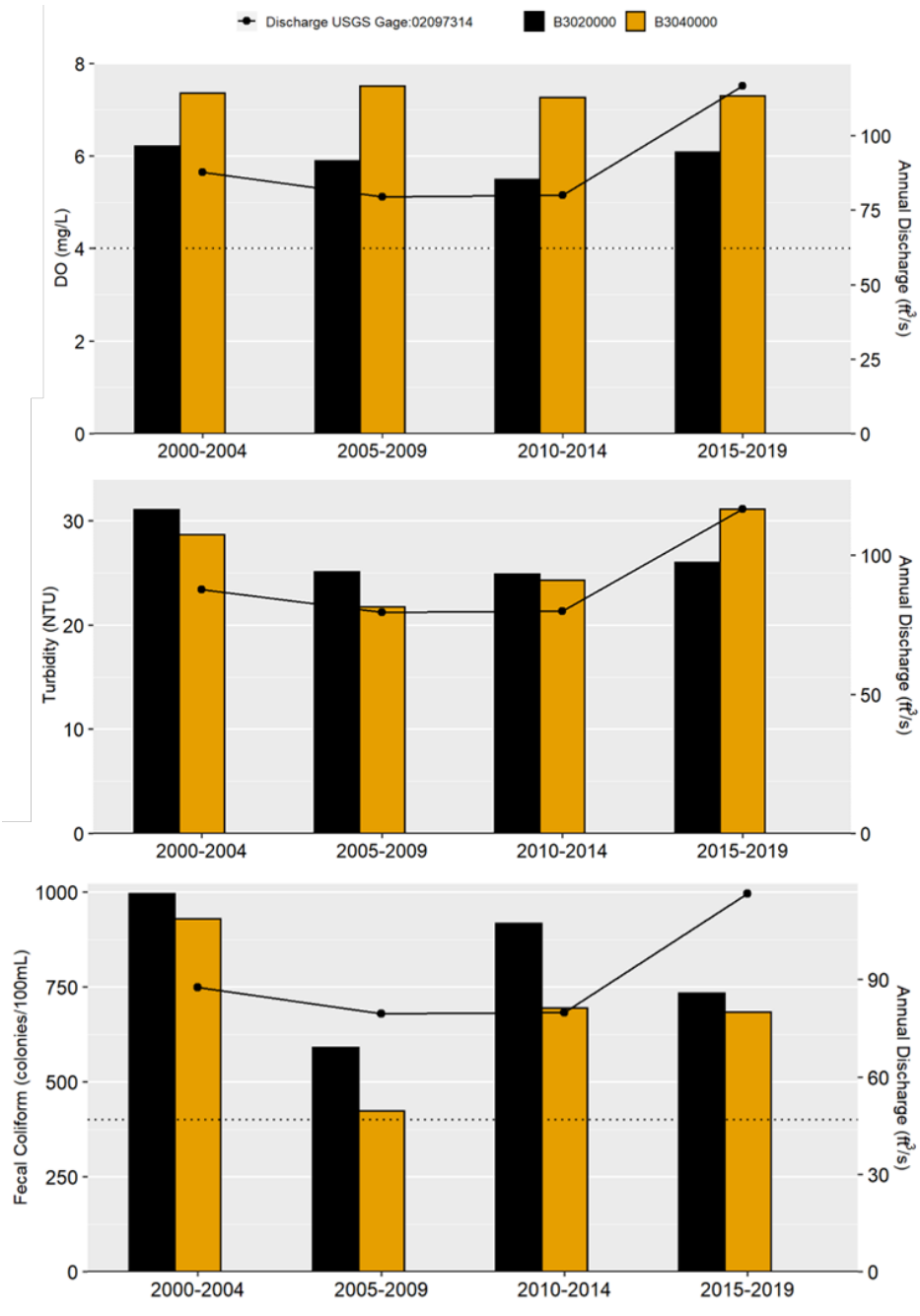
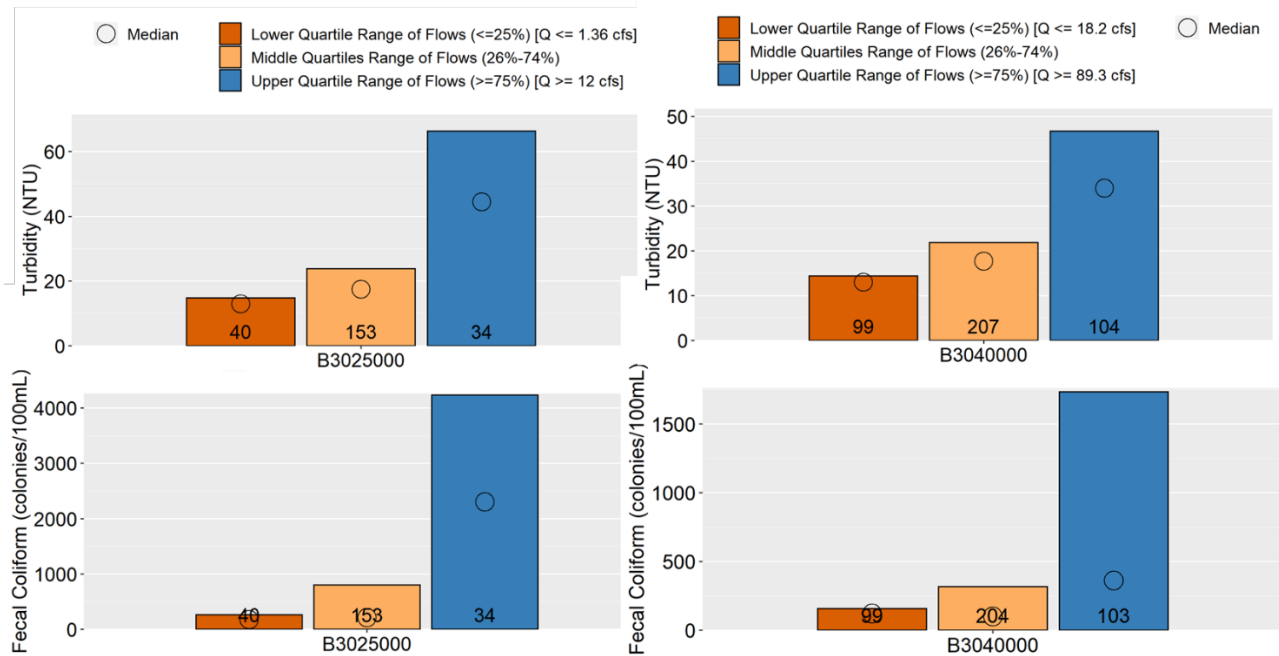


Figure 6-87: Flow Separated Mean and Median Concentrations for Turbidity and Fecal Coliform Bacteria (2002-2020) at Station B3025000 in Third Fork Creek and Co-located USGS Gage Station 02097280 (2008-2020) and B3040000 in New Hope Creek and Co-located USGS Gage Station 02097314 (1991-2020).



Elevated nutrient concentrations and loading to Jordan Lake is an issue throughout this NSW watershed. Instream TN concentrations increase significantly downstream of the South Durham WRF as seen in the 2022 IR mean TN concentration increase from 0.83 mg/L upstream at station B3020000 to 3.26 mg/L downstream at station B3040000 (Table 6-44). Figure 6-88 shows the five-year mean concentrations over the last 20 years for TN, NO<sub>x</sub>, TKN, NH<sub>3</sub>, TP, and conductivity at stations B3020000 and B3040000 in New Hope Creek with stream flow at USGS gage station 02097314. The TN is made up of mostly TKN upstream of the WWTP and NO<sub>x</sub> downstream of the treatment plan (Table 6-44, Figure 6-88, and Figure 6-89). This is very typical of watersheds with point source discharges. The elevated instream conductivity downstream of the discharge is also indicative of point source contributions (Table 6-44 and Figure 6-89). The total phosphorus instream concentrations are also significantly higher downstream of the WWTP with 2022 IR mean of 0.18 mg/L downstream versus 0.06 mg/L upstream (Table 6-44).

To determine how nutrients are impacted by stream flow in New Hope Creek, the water quality data was assessed using a flow separated technique described in section 6.3 at station B3040000 (co-located with USGS gage 02097314). As described above, the flow separated analysis supports the findings that TN, NO<sub>x</sub> and TP concentrations are directly influenced by the discharge from the South Durham WRF. The mean instream concentrations are substantially higher at low flows ( $\leq 18.2$  cfs) when the instream waste concentration is at its highest (Figure 6-90). Conductivity shows the same trend. TKN concentration is only slightly higher at the low flow rate while ammonia concentration is highest at the middle flow range with a mean concentration of 0.09 mg/L in comparison to 0.04 and 0.06 mg/L at the low and high flow rates, respectively (Figure 6-90). These patterns are fairly similar to other streams in the Cape Fear River basin influenced by large wastewater influences (Figure 6-17).

DWR conducted a seasonal Mann-Kendall trend test at stations B3020000 and B3040000 for data collected from 2000-2019 and 2010-2019 (calculated at 95% confidence) and found a decreasing trend in NH3 (2010-2019) and TP for both time periods at the upstream station B3020000 (*Table 6-44*). At the downstream station B3040000 decreasing trends were found for NH3 (2000-2019), NOx (2010-2019) and TP (2000-2019) and an increasing trend in TKN (2000-2019) (*Table 6-44*). Given the partial implementation of the Jordan Lake NSW rules and the many actions that have been taken to reduce nitrogen and phosphorus in the Jordan Lake watershed since about 2010, it is not surprising to see decreasing trends at either of these stations.

The 20 MGD [South Durham WRF \(NC0047597\)](#) lies within the Upper New Hope Creek Arm of Jordan Lake and is subject to the Jordan Lake nutrient strategy (15A NCAC 02B .0270). The Upper New Hope Creek Arm of Jordan Lake has met the overall lake arm TN (434,170 lbs/yr) and TP (32,919 lbs/yr) point source load allocation since 2015, however South Durham WRF is not consistently meeting their TN allocation of 185,345 lbs/yr which was effective January 1, 2016 (*Table 6-45*). As a result, they received a nutrient optimization special condition [a.(8.)] requirement in their [January 2023 permit](#) renewal (NC DEQ, 2022a). They are required to identify “opportunities to improve and optimize total nitrogen and total phosphorus reduction in the existing facilities beyond those previously implemented pursuant to NCGS 143-215.1B(d) and submit a report to the Division documenting its findings, proposing optimization measures, and describing expected results” by June 1, 2023 [2023 permit section A. (8). Nutrient Optimization].



*Table 6-45: South Durham Water Reclamation Facility Annual Total Nitrogen and Total Phosphorus Jordan Lake Allocation and their Yearly Load between 2016 and 2022.*

South Durham WRF NC0047597	Allocation lbs/yr	Delivery Factor	2016 lbs/yr	2017 lbs/yr	2018 lbs/yr	2019 lbs/yr	2020 lbs/yr	2021 lbs/yr	2022 lbs/yr
<b>Total Nitrogen</b>	185,345	75%	173,454	173,792	205,465	184,629	200,085	188,774	162,974
<b>Total Phosphorus</b>	14,053	67%	8,755	7,058	10,221	11,710	8,008	11,198	12,208

Jordan Lake nutrient strategy (15A NCAC 02B .0262)

According to the permit fact sheet, their average discharge from August 2018-July 2022 was 9.55 MGD with a maximum of 41.36 MGD. Their average effluent TN and TP concentrations were 6.74 and 0.36 mg/L, respectively (NC DEQ, 2022b). South Durham WRF will also monitor their effluent for 1,4-Dioxane monthly and various PFAS quarterly after the EPA method is published [2023 permit section A. (1.) and A.(13.); NC DEQ, 2022a].

For more information see the larger point source discussion in the Jordan Lake section below and the Jordan Lake point source loading chart in Chapter 6 Appendix.

Figure 6-88: Five-Year Average Total Nitrogen, Nitrate+Nitrite-Nitrogen, Total Kjeldahl Nitrogen, Ammonia-Nitrogen, Total Phosphorus and Conductivity Concentrations at Stations B3020000 (Black Bar) and B3040000 (Orange Bar) in New Hope Creek with Stream Flow at USGS Gage 02097314.

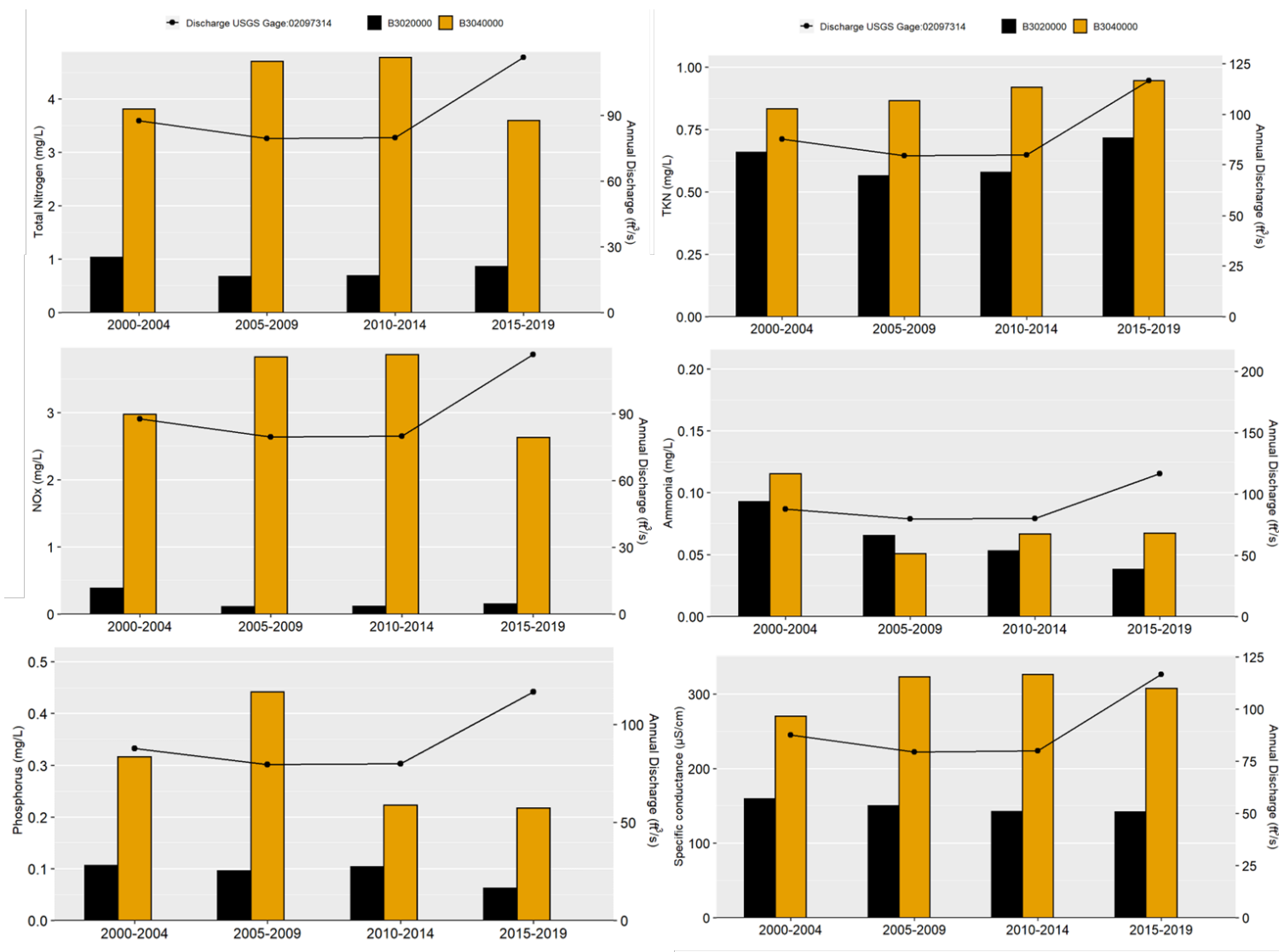


Figure 6-89: New Hope Creek Yearly Mean Nitrogen Constituent Concentrations at Stations B3020000 and B3040000 with Flow from USGS Gage 02097314.

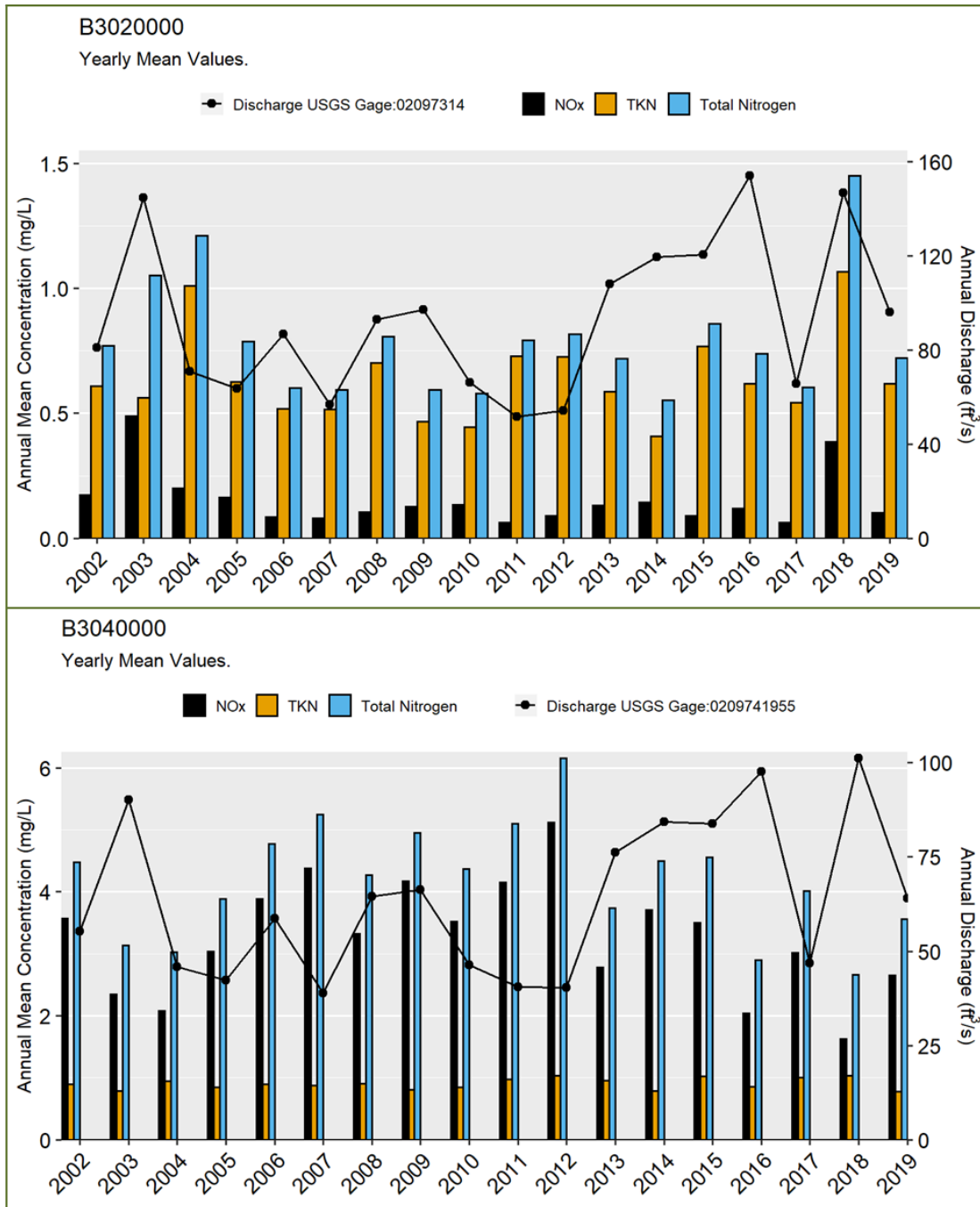
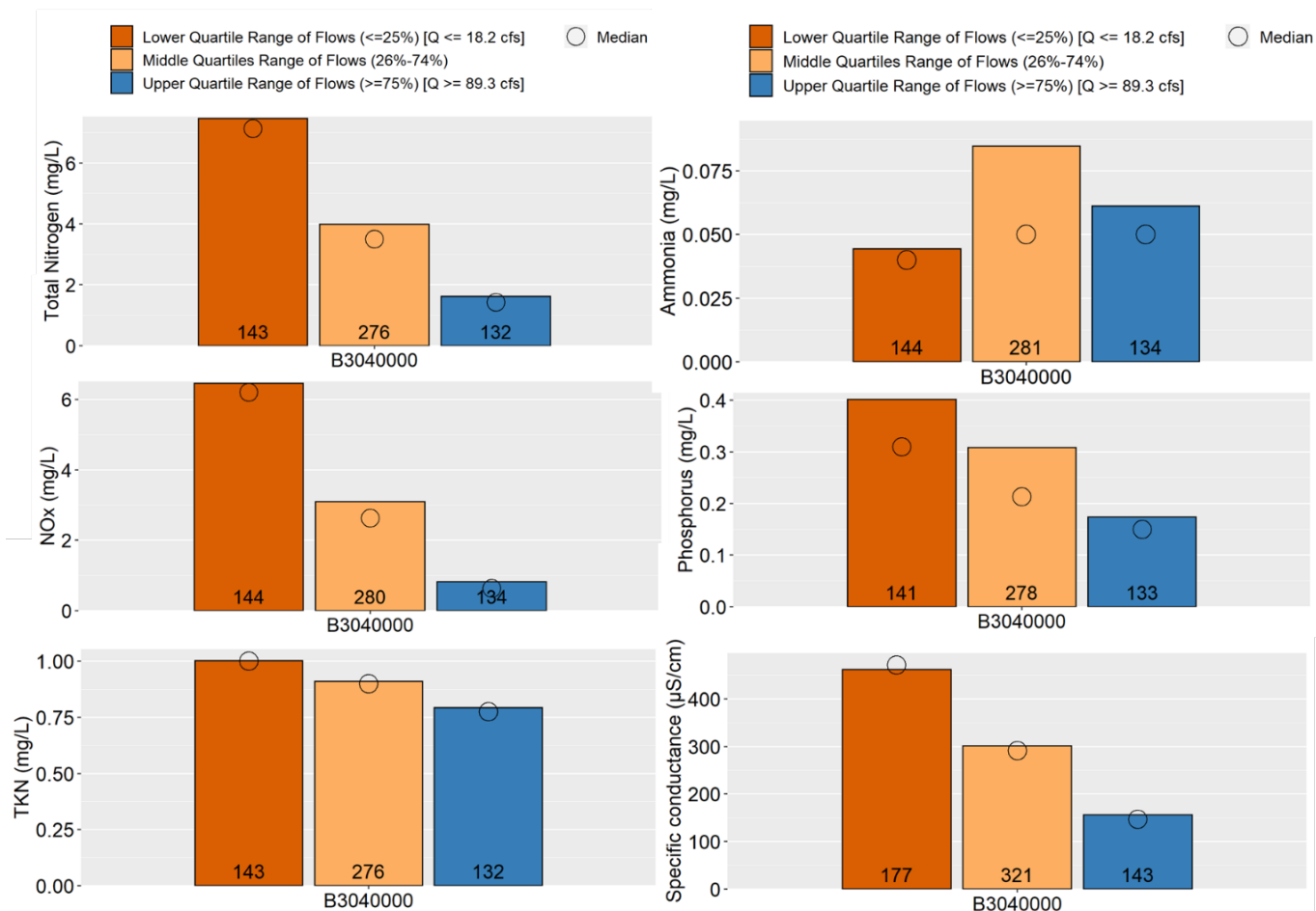


Figure 6-90: Flow Separated Mean and Median Concentrations for Nutrients and Conductivity (2002-2020) at Station B3040000 in New Hope Creek and Co-located USGS Gage Station 02097314 (1991-2020).



### Third Fork Creek

The headwaters of Third Fork Creek [AU# 16-41-1-12-(1) and 16-41-1-12-(2)] starts on the southwest side of Hwy 147 near South Briggs Avenue and flows through the City of Durham and drains to New Hope Creek near I-40 between the two ambient water quality stations. Within the drainage area of this stream segment there is a single groundwater remediation site, a few single-family NPDES wastewater permits and several stormwater permits. Third Fork Creek is impaired for biology, copper and total suspended solids (2022 IR) (Table 6-42). There is a single ambient monitoring station (B3025000) used to assess the water quality in this watershed (Figure 6-16). There was a RAMS station (B2970000) at Hwy 55 in the upper portion of the creek monitored in 2007-2008. The 2019 land use has not changed substantially at station B3025000 since 2001, which captures most of the watershed draining to New Hope Creek. Development increased from 85 to 87% with forest declining from 10 to 8% respectively. The impervious cover in 2019 is estimated to be 25%, which is up from 22.2% in 2001.

In January 2005, the US EPA approved a turbidity/total suspended solids (TSS) [TMDL for Third Fork Creek](#). The TMDL calls for a 53% reduction in TSS in order to meet the water quality standard. The TMDL used

TSS as a surrogate variable for turbidity and set the instream target to be less than 26 mg/L TSS. It was determined that a 50 NTU turbidity corresponded to a 29 mg/L TSS value in Third Fork Creek. A watershed assessment completed for this TMDL identified development activities such as land clearing, site preparation and roadways as the main source of turbidity. Other nonpoint and point sources were also identified as contributing to the overall sediment load. The TMDL indicated that wet weather under high-flow period is the critical period for turbidity in the Third Fork Creek area.

DWR conducted a seasonal and non-seasonal Mann-Kendall trend test at stations B3025000 for data collected from 2000-2019 and 2010-2019 (calculated at 95% confidence) and found no significant change in turbidity concentrations (*Figure 6-91* and *Figure 6-92*). The 2022 IR mean turbidity concentration was 31.2 NTU with a median of 15.6 NTU and a maximum of reading of 230 NTU (*Table 6-44*). The yearly mean concentrations have ranged from about 16 to 62 NTU and the percent exceedances ranging from zero to 36% and the does not seem to be a direct link to yearly mean flows (*Figure 6-91*). However, when the turbidity data is separated by flow, the high flow (top 25<sup>th</sup> percentile flow) mean and median concentrations are substantially higher at 66 and 45 NTU, respectively (*Figure 6-87*). The middle/normal (mean=23.8 NTU) and low (mean=14.7 NTU) flows are somewhat similar, which holds true for the other stations in this Upper New Hope Creek subwatershed (*Figure 6-87* and *Figure 6-17*).

It appears that there was some activity (possible construction project) occurring in the watershed which resulted in four very high instream turbidity readings resulting in the high yearly mean of 62 NTU and a 36% exceedance of the 50 NTU standard (*Figure 6-91* and *Figure 6-92*). The maximum recorded reading was 230 NTU on November 5, 2018, with a corresponding high fecal coliform bacteria concentration of 5,200 cfu/100mL. The daily mean flow increased from 3.9 cfs on November 4<sup>th</sup> to 247 cfs on November 5<sup>th</sup>, indicating a large storm event occurred in the watershed. The yearly mean flow was high in 2018 (28.9 cfs) and in 2020 (33.5 cfs), however the impact was very different as the yearly turbidity mean in 2020 was 24.4 NTU with a max reading of 80.5 NTU and only 8.3 percent of the samples greater than 50 NTU. The 2005 turbidity TMDL referenced above identified development activities as the main source of elevated turbidity in the Third Fork Creek watershed. It is critical that development activities improve their efforts to limit the export of sediments from the landscape to surface waters. The upper portion of Jordan Lake [AU# 16-41-1-(14)] which Third Fork Creek and New Hope Creek drains to is also impaired due to elevated turbidity (*Table 6-42*). It is activities in these watersheds that are contributing to the impairments in Jordan Lake.

The Third Fork Creek copper impairment is based on a historical total copper assessment which added Third Fork Creek to the 2008 impaired waters list [303(d)]. North Carolina adopted new dissolved metals water quality standards in 2014 ([15A NCAC 02B .0211](#)). When resources allow, Third Fork Creek should be reassessed for dissolved metals. A likely source of copper in urban streams is from motor vehicle brake pad dust. In 2015, the EPA and the auto industry signed an agreement to reduce the use of copper and other materials in brake pads in an effort to decrease the runoff of these materials from roads into surface waters ([EPA Copper-Free Brake Initiative](#)). Copper from stormwater runoff can affect fish, amphibians, invertebrates and plants. This could be one factor associated with the benthic macroinvertebrate impairment.

Third Fork Creek is listed as impaired due to an old Poor benthic macroinvertebrate assessment (*Table 6-42*). If the dissolved copper reassessment shows no instream impairment or the watershed shows signs of recovery, *DWR should resample stations BB460 and BF116*, to determine if the impairment persists.

*Figure 6-91: Third Fork Creek Annual Mean Turbidity Concentration with Corresponding Percent Exceedance of the 50 NTU State Standard at Station B3025000 and Annual Mean New Hope Creek Flow at USGS Gage 02097314.*

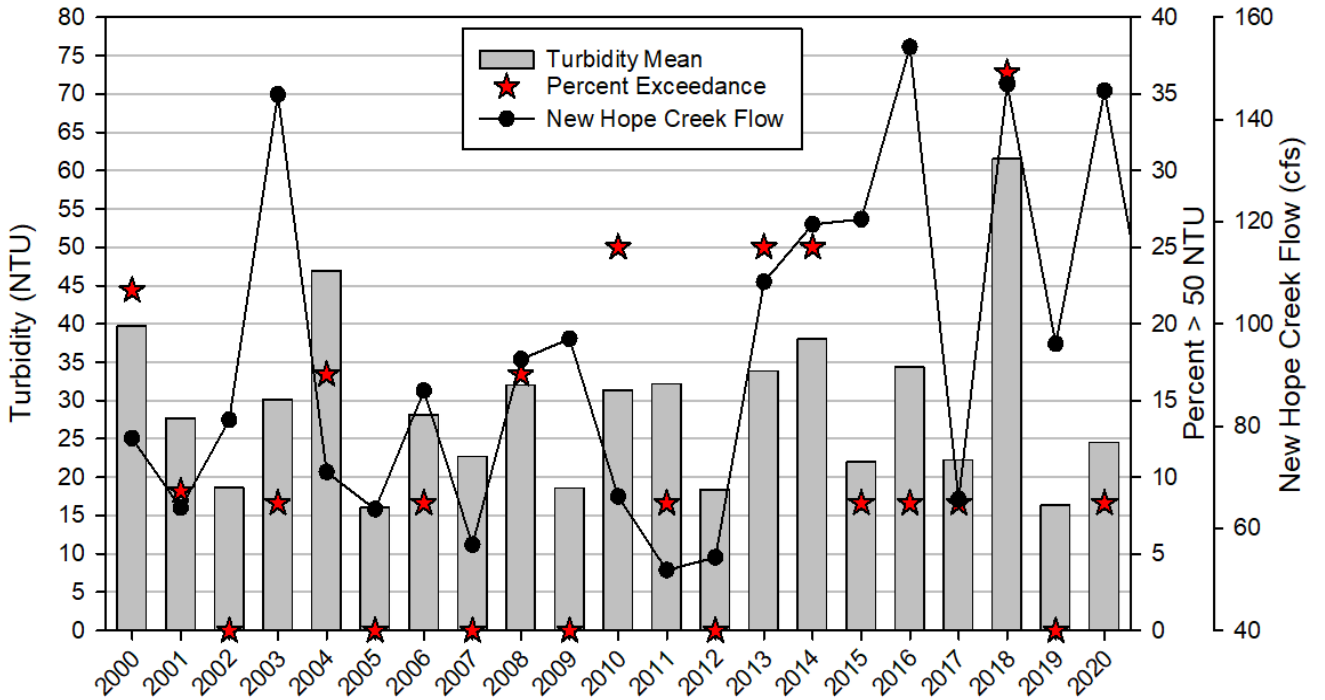
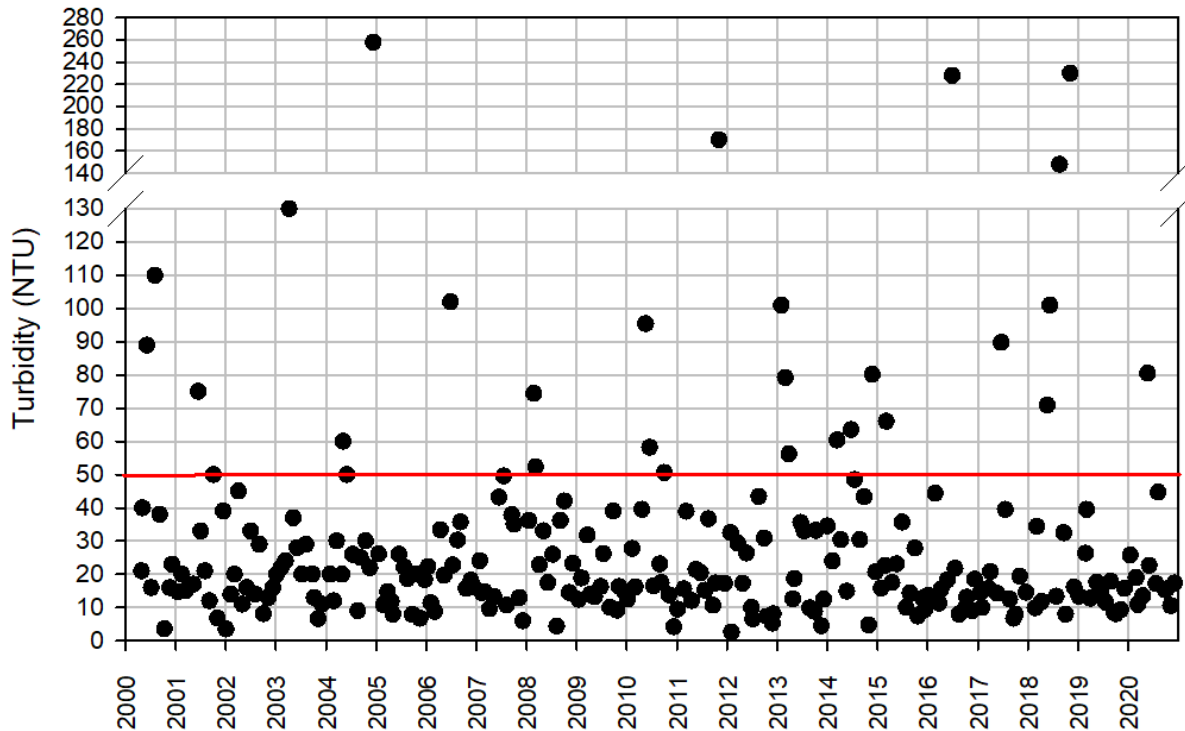
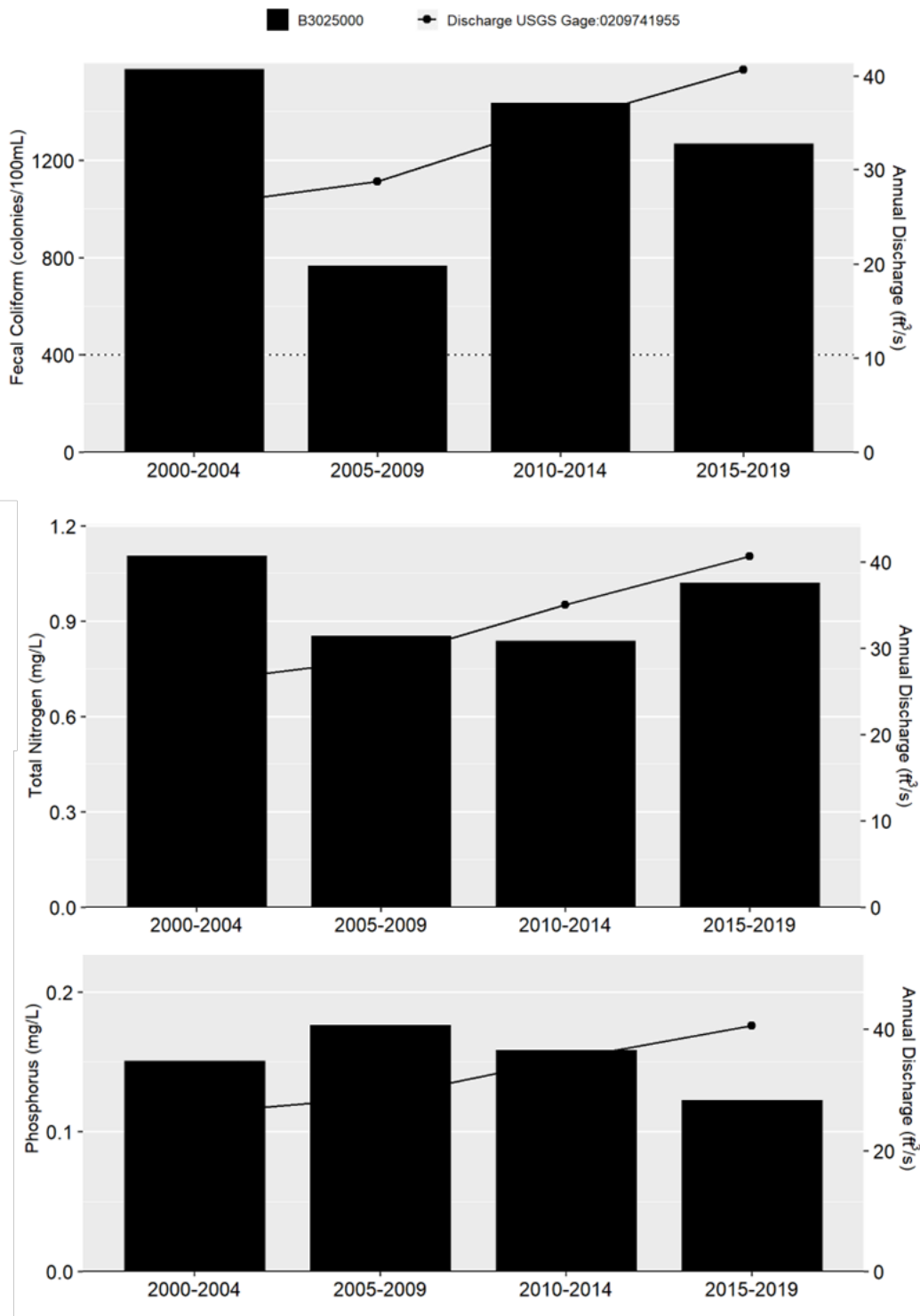


Figure 6-92: Third Fork Creek Turbidity Raw Data from 2000 through 2020 at Station B3025000. Note the Scale Break on the Turbidity Y-Axis and the Red Line Denotes the State Standard of 50 NTU.



Third Fork Creek is listed as data inconclusive due to elevated instream concentration of fecal coliform bacteria with a 2022 IR mean of 1,391 cfu/100 mL and 29% of the samples exceeding the 400 cfu/100 ml standard and a geometric mean of 335 (Table 6-42 and Table 6-44). A 5-in-30 assessment would be needed in order to give Third Fork Creek an official use support rating of supporting or impaired. Due to limited resources, DWR prioritizes class B, primary recreational waters for this assessment. For more information on how waters are assessed for fecal coliform bacteria see section 2.5.4. The fecal coliform bacteria five-year mean concentrations have varied somewhat over the last 20 years ranging between about 800 and 1,600 cfu/100mL (Figure 6-93). When the fecal data is separated by flow, the high flow (top 25<sup>th</sup> percentile flow) mean (4,233 cfu/100 mL) and median (2,300 cfu/100 mL) concentrations are substantially higher than the middle and low flow range (Figure 6-87). The mean for the middle/normal is still very high (800 cfu/100 mL) (Figure 6-87). This data shows there is a considerable need to control stormwater runoff in the Third Fork Creek watershed.

Figure 6-93: Five Year Average Fecal Coliform Bacteria, Total Nitrogen and Total Phosphorus Concentrations at Station B3025000 in Third Fork Creek with Stream Flow at USGS Gage 0209741955.



The 2022 IR period instream nutrient concentrations in Third Fork Creek are slightly higher than upper stream segments above the point source dischargers of New Hope Creek, Northeast Creek and Morgan

Creek (Table 6-44). The five-year TN mean concentration ranged from about 0.8 to 1.1 mg/L over the last 20 years (Figure 6-93). The TN is made up of mostly organic nitrogen (as seen by TKN which is made up of organic nitrogen and NH<sub>3</sub>) as opposed to NO<sub>x</sub> or NH<sub>3</sub> (Figure 6-94 and Table 6-44). The 2022 IR mean TKN concentration was 0.74 mg/L while NH<sub>3</sub> was only 0.04 mg/L or only 5.4% of the TKN value indicating that the largest portion of the TN signature is organic nitrogen (Figure 6-94 and Table 6-44). The flow, however, did not impact the overall instream nutrient concentrations much (Figure 6-95). The TKN and NO<sub>x</sub> mean concentrations increased with the increasing flow with the mean TKN concentrations of 0.66, 0.74 and 0.82 mg/L at low, medium and high flows, respectively (Figure 6-95). The NO<sub>x</sub> concentration nearly doubled from the low flow mean of 0.13 mg/L to 0.24 and 0.25 mg/L at the medium and high flow values, respectively (Figure 6-95). The 2022 IR TP instream concentration was twice as high (0.12 mg/L) as the upper portion of New Hope Creek (0.06 mg/L) (Table 6-44). The five-year means have declined from about 0.18 to 0.12 mg/L (Figure 6-93).

DWR conducted a seasonal Mann-Kendall trends test at stations B3025000 for data collected from 2000-2019 and 2010-2019 (calculated at 95% confidence) and found a decreasing TP trend for both time periods and a decreasing NH<sub>3</sub> trend between 2010 and 2019 (Table 6-44).

With the high amount of development (87%) and impervious cover (25%) in the Third Fork Creek watershed, implementation of Jordan Lake stormwater rules is crucial in order to reduce nutrient, turbidity and fecal coliform bacteria loading from this watershed. Urban type BMPs are needed to intercept runoff and encourage infiltration where possible.

Figure 6-94: Third Fork Creek Yearly Mean Nitrogen Constituent Concentrations at Stations B3025000 with Flow from USGS Gage 0209741955.

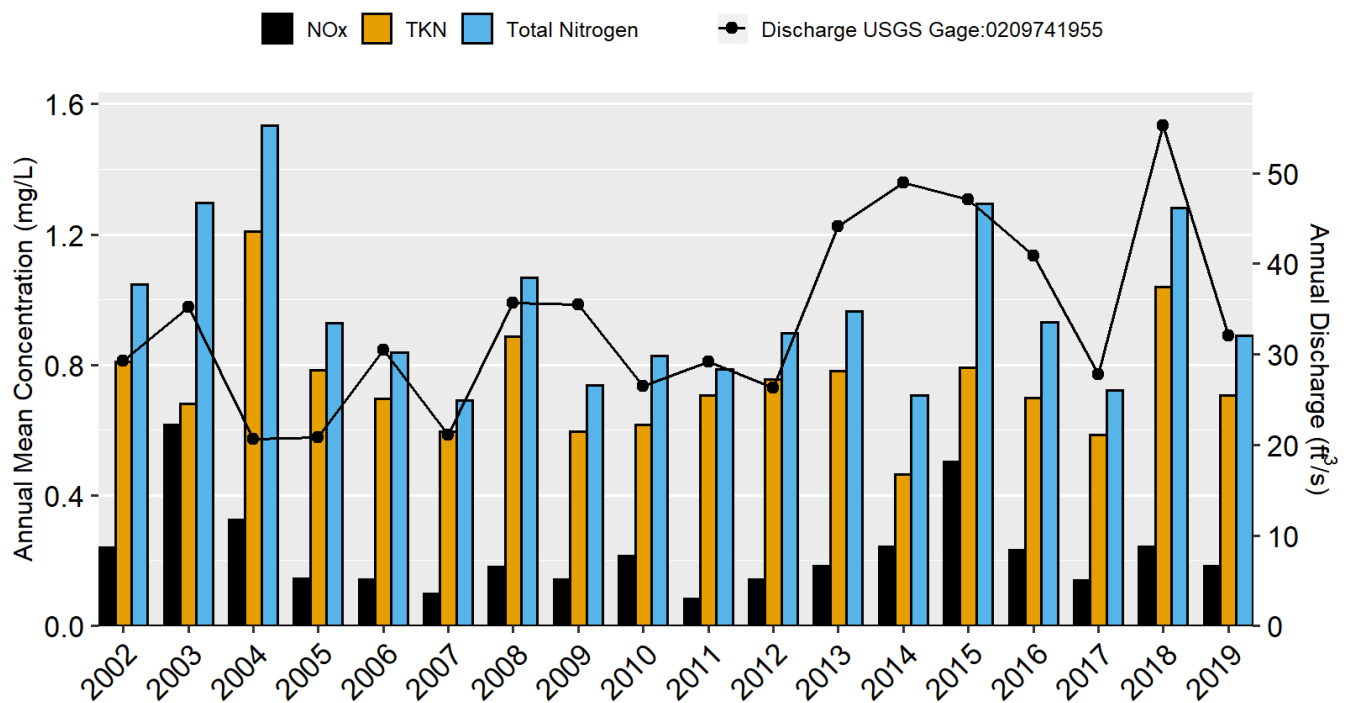
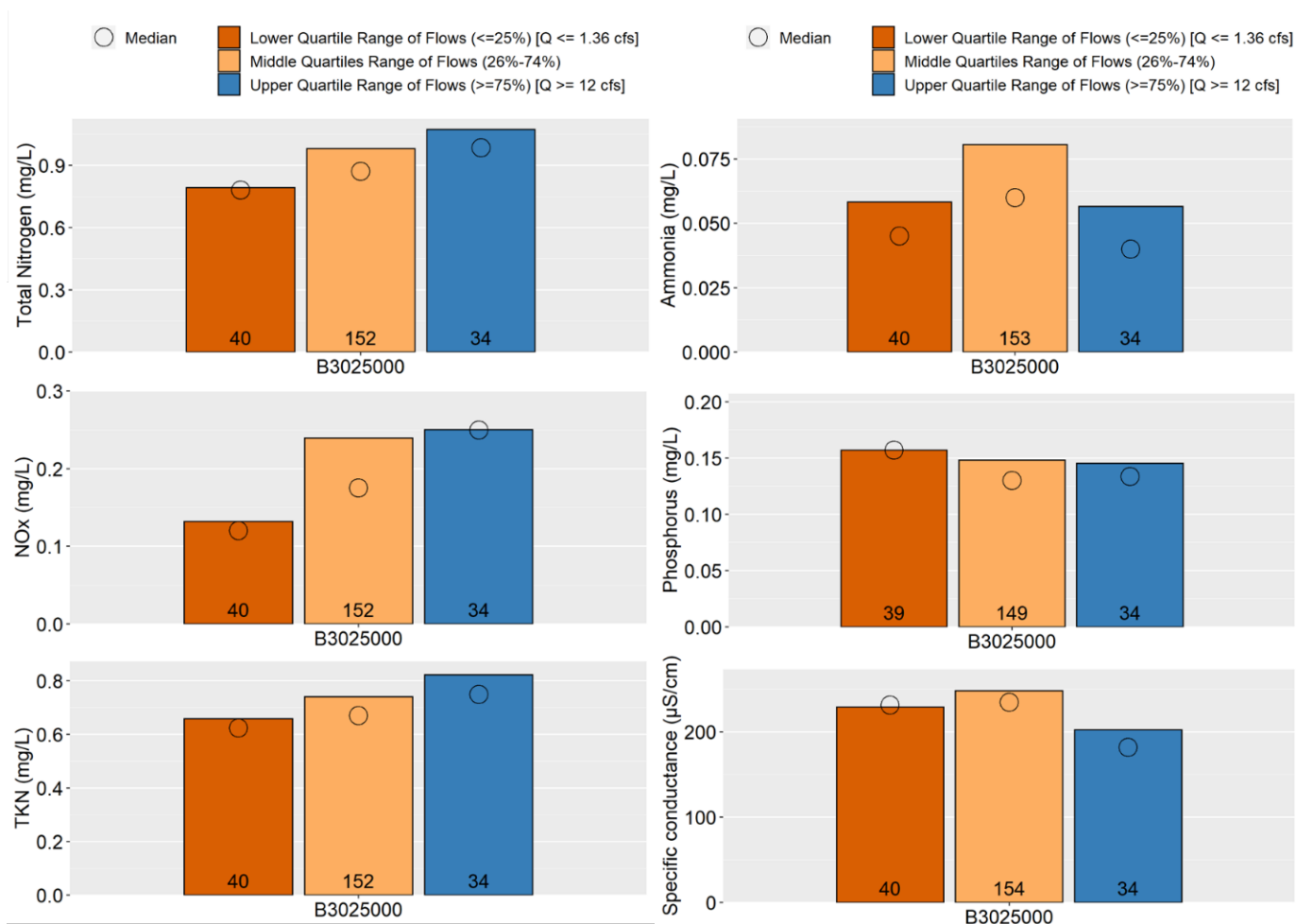


Figure 6-95: Flow Separated Mean and Median Concentrations for Nutrients and Conductivity (2002-2020) at Station B3025000 in Third Fork Creek and Co-located USGS Gage Station 02097280 (2008-2020).



See section 6.3 for data analysis description. High flows  $\geq$  75<sup>th</sup> percentile; Medium flows between 26<sup>th</sup> and 74<sup>th</sup> percentile; Low flows  $\leq$  25<sup>th</sup> percentile at USGS Gage Station 0297280 (8/2008-2020).

In 2012, the City of Durham developed a [Third Fork Creek Watershed Management Plan](#) and has since started a [Third Fork Creek/Lakewood Avenue Stream Stabilization and Enhancement Project](#) with the goal of reducing sediment and fecal coliform bacteria to improve instream water quality and habitat. Part of this project includes a sanitary sewer replacement project. This project will improve the environment while protecting infrastructure such as sidewalks. For more information on the City of Durham watershed restoration projects see their [website](#).

The City of Durham has an interlocal agreement with the Durham County Soil and Water Conservation District to help support the Community Conservation Assistance Program (CCAP). From 2019-2022, six projects were installed, one in Mud Creek watershed and five in Third Fork Creek watershed. They

included three downspout disconnections, one rain garden and two cisterns to help capture stormwater runoff from urban sources. The City of Durham renewed their agreement in 2023. For information and eligibility for CCAP projects in your area see your county Soil and Waters Conservation agents. In Durham County see the following [CCAP link](#).

*DWR recommends implementation of the Third Fork Creek Watershed Management Plan and continued support for the Durham County Soil and Water Conservation Districts Community Conservation Assistance Programs efforts.*

*6.6.6.2 Bolin, Booker and Little Creeks*

Bolin Creek drainage area comprises a significant portion of the Little Creek subwatershed (030300020603) and is located in the Chapel Hill/Carrboro area of Orange County. Bolin Creek includes three assessment units (AUs) for its approximate 9.4-mile length from its headwaters in Orange County (northwest of Carrboro boundary) to the confluence with Booker Creek in Chapel Hill. Bolin and Booker creeks join to form Little Creek that flows into the upper New Hope Creek arm of Jordan Lake [AU# 16-41-1-(14)].

**Bolin Creek**

Bolin Creek [AU# 16-14-1-15-1-(0.5)a] from the source to Pathway Drive is listed as supporting or meeting criteria on the 2022 IR due to a 2001 Good-Fair benthic assessment at BB330.

Bolin Creek [AU # 16-14-1-15-1-(0.5)b and 16-14-1-15-1-(4)] from Pathway Dr to Little Creek remains listed as impaired on the 2022 IR due to several Fair and Poor benthic macroinvertebrate ratings from 2001 and 2002. The biologists found mainly tolerant and low dissolved oxygen indicator species. It is believed that urban runoff is contributing to the lower biological ratings. Benthic community site BB506 was sampled in 2009 and received a bioclassification of Good-Fair, but this AU remains impaired for biology.

A 2018 fish assessment was conducted at BF14, which runs parallel to South Estes Dr and is located between a mall and an apartment complex. The biologists described this segment of Bolin Creek as having poor to moderate quality habitat with thin riparian area, entrenched channel, scoured banks and mostly sandy substrates mixed with some gravel. It was evident that sedimentation and persistently elevated conductivities in this urban watershed have negatively impacted fish species diversity at this location. The conductivity was recorded at 209 µS/cm with a DO of 7.9 mg/L

<b>Bolin Creek BB330</b>	
<b>Year</b>	<b>Bioclassification</b>
2001	Good-Fair
<b>BB506</b>	
2009	Good-Fair
<b>BB449</b>	
2002	Fair
<b>BB062</b>	
2002	Poor
<b>BB071</b>	
2001	Poor
<b>BF47</b>	
2001	Good
<b>BF8</b>	
2001	Good
<b>BF14</b>	
2013	Good-Fair
2018	Good-Fair
<b>Little Creek BB197</b>	
2001	Poor & Not Rated



on April 4, 2018. Since Bolin Creek has been consistently rated as Good-Fair since 1998, this suggests a relatively stable stream condition.

In 2006, the towns of Chapel Hill and Carrboro worked together with state and federal agencies and local stakeholders to create the Bolin Creek Watershed Restoration Team (BCWRT). The long-term goal of BCWRT is to improve the health of Bolin Creek and its tributaries and remove it from the impaired waters list. Both towns have very active and engaged stormwater management programs in place to protect the health and safety of both the public and the ecosystem, address stormwater quality and quantity concerns, and ensure compliance with federal and state stormwater mandates. Both towns are NPDES Phase II communities. Each town's stormwater programs include stream restoration efforts and regular biological monitoring to assess changes occurring due to development and stream restoration efforts ([Carrboro's website](#); [Chapel Hills website](#)).

In 2008, together the towns received a 319 grant that included stream restorations, stormwater retrofits and the development of the 2012 [Bolin Creek Watershed Restoration Plan](#). Both towns have continued to work together to fund watershed restoration projects and have received CWMTF and 319 grant funds to support their efforts (see their websites for additional information). These grants helped to implement stormwater management measures and stream restorations at Baldwin Park and McDougle Elementary School.

The upper section of Bolin Creek flows through the Town of Carrboro. The town's [website](#) indicates *"the primary regulatory tool the Town employs to protect creeks and streamside environments from new development is the [Land Use Ordinance](#). [Watershed restoration](#) efforts require non-regulatory approaches to treat stormwater from existing development, improve stream buffers, and repair creek channels."* Carrboro continues to collect benthic macroinvertebrate samples and have found that many of their stations fluctuate between Good-Fair and Fair. Their most recent (2022) benthic report is available [here](#).

In 2021 the Town of Carrboro, collaborating with neighborhoods in the watershed, received 319 grant funds to support the following actions ([project website](#)):

- Stabilize eroding ephemeral channels and adjacent areas.
- Provide educational outreach to neighbors and other interested partners.
- Add native vegetation to streambanks and eroded areas.
- Show what is possible with community collaboration.

The lower section of Bolin Creek flows through the Town of Chapel Hill. Chapel Hill covers a larger section of the watershed which also includes Booker and Little Creek. Since 2011, the Town of Chapel Hill has monitored about 30 sites annually along the mainstem of Bolin Creek and tributaries across their zoning jurisdiction. They sample benthic macroinvertebrates, conduct habitat assessments and collect water quality parameters, all using DEQ protocols. Detailed reports are available on the town's [biological monitoring website](#) . As stated above, the Town of Chapel Hill participated in the development of the restoration plan and participates in restoration efforts in Bolin Creek and other watersheds within its jurisdiction (see their [watershed assessments and plans website](#) for more information). In 2023, the town is developing a volunteer [Stream Team](#) water quality monitoring program to monitor the health of their local creeks starting in the fall of 2023.

A watershed assessment conducted in 2003 on the impairment of Little Creek (including Bolin Creek) watershed identified scour and widespread habitat degradation from sedimentation and storm sewer flow, runoff from impervious surfaces, toxicity, low dissolved oxygen and organic enrichment as stressors to Bolin Creek's aquatic community.

In 2004, the Division of Mitigation Services (formerly Ecosystem Enhancement Program- EEP) completed a [Local Watershed Plan \(LWP\) for Morgan and Little Creek watersheds](#). The LWP proposed management measures for addressing issues in the watershed. Several locations for potential stormwater management measures were included in the plan. For additional details on DMS Cape Fear River Basin documents, visit the DMS website [here](#).

### **Booker Creek**

Booker Creek's drainage area comprises a significant portion of the Little River subwatershed (030300020603) and is located in the Chapel Hill area of Orange County. Booker and Bolin creeks come together to form Little Creek.

Booker Creek [AU# 16-41-1-15-2-(1)] from the source to Eastwood Lake is listed on the 2022 IR as impaired due to low DO standard violations that occurred at the RAMS B3050000 station monitored between 2007 and 2008 (*Table 6-42*). The DO concentration was below 4 mg/L more than 30% of the time with a minimum recorded reading of 1.3 mg/L. The entire area around Jordan Lake experienced a long-term drought throughout much of the RAMS assessment period of 2007-2008.

The entire 5.6-mile length of Booker Creek [AU# 16-41-1-15-2-(1), 16-41-1-15-2-(4) and 16-41-1-15-2-(5)] from the source to the Little River is listed as impaired on the 2022 IR due to historic benthic macroinvertebrate bioclassifications (*Table 6-42*). The biologists concluded that the combination of urban land use, low flows and reduced instream habitat are likely the sources suppressing the bioclassification in Booker Creek. A 2001 special study was conducted, and all of the stations were classified as data inconclusive due to extended drought issues identified at the time of sampling, therefore the prior impaired rating remains in place.

A 2003 DWQ Watershed Assessment and Restoration Project (WARP) / Water assessment Team (WAT) study identified toxicity, low DO, organic enrichment, scour, and widespread habitat degradation from sedimentation from storm sewers and runoff from impervious surfaces as being stressors to the biological communities.

Booker Creek was included as part of the 2004 DMS [Local Watershed Plan \(LWP\) for Morgan and Little Creek watersheds](#). The LWP proposed management measures for addressing the problems in the watershed. Several locations for potential stormwater management measures were included in the plan. For additional details on the DMS Cape Fear River basin plans, visit DMS website [here](#).

## Little Creek

Little Creek [AU# 16-41-1-15-(0.5)] from the confluence of Booker and Bolin creeks to Durham County SR 1110 (Pinehurst Dr.) is currently listed on the 2022 IR due to historic benthic macroinvertebrate monitoring at station BB197 ([Table 6-42](#)).

*As time and resources allow, DWR should consider resampling several of the biological stations to determine if the impairment persists. Given the size and urban drainage occurring in this watershed, DWR should consider adding an ambient water quality monitoring station in Little Creek (possibly at Pinehurst Dr.) to capture the nutrient contribution and assess the many other water quality parameters which may help explain the biological conditions throughout this watershed. Elevated conductivity captured at the biological stations and the low DO identified in Booker Creek are indicators that this is a heavily urbanized watershed that should be captured in our understanding of the watersheds draining to Jordan Lake.*

The City of Durham's Watershed Restoration group completed a [New Hope and Little Creek Watershed Improvement Plan](#) in 2021. A watershed assessment and improvement plan provided a review of their water quality monitoring data, identified impacts and sources to watershed functions and developed a comprehensive summary of potential projects throughout the watershed.

### 6.6.6.3 Morgan Creek and Wilson Branch

Morgan Creek [AU#s 16-41-2-(1), 16-41-2-(1.5), 16-41-2-(5), 16-41-2-(5.5)a, 16-41-2-(5.5)b, and 16-41-2-(9.5)] drains the southwestern portions of Chapel Hill and Carrboro in southeast Orange County.

The headwaters of Morgan Creek originate in the upper northwest corner of the New Hope Creek/Jordan Lake watershed in Orange County and flows in a southeasterly direction forming University Lake, a water supply for Chapel Hill. Morgan Creek leaves the water supply impoundment and flows through the southern portion of the Town of Carrboro and Chapel Hill, then through the southwestern corner of Durham County. Morgan Creek enters the Morgan Creek arm of the Upper New Hope section of Jordan Lake just south of the Chatham County line.

In 2010, EPA approved an addendum to the Jordan Lake TMDL which added University Lake (NC DENR-[DWQ 2010 University Lake TMDL](#)). The TMDL requires nutrient load reductions from all sources in the watershed, similar to the Upper New Hope arm of the Jordan Lake Rules. In 2010, the TMDL required 35% reduction in TN and 5% reduction in TP. See the Jordan Lake section below (Section [6.6.6.9](#)) for more details on the nutrient reduction strategy and the rules reassessment schedule.

Implementation measures to improve Jordan Lake will result in improvements in University Lake. There were two University Lake stations assessed in 2018, two instream ambient water quality monitoring stations, and three biological samples collected since the previous basin plan (one benthic macroinvertebrate and two fish). The 14.5 MGD Orange Water and Sewer Authority (OWASA) Mason Farm WWTP (NC0025241) discharges into Morgan Creek between the two water quality stations ([Table 6-43](#)). The downstream station (B3900000) was used to assess the water quality prior to entering the Morgan Creek arm of Jordan Lake. The mean nutrient concentrations are high at this station when compared to the suggested DWR healthy Piedmont stream concentrations ([Table 6-10](#)). The land cover land use has not changed much in this watershed between 2001 and 2019. The percent developed

increased from 24 to 26% and the impervious cover increased from 5 to 5.7%, with the majority of the watershed being forested at 60% in 2019 (2001 and 2019 NLDC).

Morgan Creek [AU# 16-41-2-(1)] from the source to a point 1.4 miles downstream of NC Hwy 54 is a Water Supply-II (WS-II), High Quality Water (HQW) watershed and is currently (2022 IR) supporting or meeting criteria based on a 2018 Good benthic macroinvertebrate bioclassification at station BB146 (*Table 6-42*).

The benthic community station BB146 is located where NC-54 crosses Morgan Creek [AU#16-41-2-(1)]. This stream drains a portion of south-central Orange County. The March 2008 sample was taken during the 2008 drought and should not have been rated but was assigned a Fair bioclassification. A year later in 2009, the bioclassification increased from Fair to Good. The biological community was very similar to the 2003 collection and appears to have recovered from the drought. Morgan Creek continued to support some intolerant EPT taxa, however taxa richness in 2013 resulted in a Good-Fair bioclassification. Intolerant taxa collected included the mayflies *Habrophlebioides* and *Leucrocota* and the caddisfly *Pycnopsyche*. Additionally, a rare caddisfly, *Neophylax atlanta*, was collected at this location in 2013. Similar to other Carolina Slate Belt tributaries, Morgan Creek EPT fauna could be affected by flow as observed by the Fair rating that occurred during the 2008 drought. Carolina Slate Belt streams are known to exhibit dry conditions nearly every summer due to their low water tables. The bioclassification fluctuations in Morgan Creek suggests EPT richness may be affected by natural seasonal flow variation in this ecoregion coupled with various nonpoint source pollutants. Forest cover declined by 10% between 1992 and 2006 as development and agricultural practices in the catchment have increased.



Year	Bioclassification
<b>BB146</b>	
2004	Good-Fair
2008	Fair
2009	Good
2013	Good-Fair
2018	Good

In 2018, Morgan Creek received a Good bioclassification. This Good benthic bioclassification suggests a water quality improvement from that observed in 2013. The mostly intolerant stonefly *Acroneuria abnormis* was common at this sampling station along with other intolerant taxa such as the mayflies *Danella spp.* (rare at the site), *Eurylophella verisimilis* (abundant), *Habrophebiodes spp.* (rare at the site), and the caddisflies *Ceraclea neffi*, *Neophylax atlanta*, *Nyctiphylax spp.*, *Rhyacophila fenestra/ledra*, and *R. glaberrima/montana*. This sampling station exhibited a rich and relatively intolerant benthic fauna in 2018. Future benthic samples in Morgan Creek are recommended to assess water quality impacts or improvements in this catchment.

Morgan Creek [AU# 16-41-2-(1.5)] from a point 1.4 miles downstream of NC Hwy 54 to the dam at University Lake is a WS-II, CA, HQW watershed. University Lake was constructed in 1932 and is managed by the Orange County Water and Sewer Authority (OWASA) and provides water for the City of Chapel Hill. The 163.3-acre lake was monitored monthly from May through September 2018. University Lake is currently (2022 IR) listed as impaired due to excess chlorophyll *a* concentrations which ranged between 37 and 80 µg/L in 2018 (*Table 6-42*). The lake had a trophic status classified as eutrophic throughout most

of the 2018 assessment with August being hypereutrophic (*Figure 6-67*). The TMDL for University Lake addresses the need to reduce excess nitrogen and phosphorus concentrations.

There is no data available to assess the 1.6-mile segment of Morgan Creek [AU# 16-41-2-(5)] from the dam at University Lake to Orange County SR 1919 (Smith Level Rd). This segment is likely impacted due to stream flow and species migration restriction as result of the dam at University Lake.

Morgan Creek [AU# 16-41-2-(5.5)a] from Orange County SR 1919 (Smith Level Rd) to the confluence with Meeting of the Waters Creek is classified as Water Supply-IV (WS-IV) as Morgan Creek drains to Jordan Lake, a WS-IV waterbody.



Fish community site BF147 in this segment of Morgan Creek was a new 2018 basin site and is located approximately one mile upstream of the Mason Farm WWTP, with the sewer right of way running alongside the creek. High quality riparian habitats here include steep hillsides with bedrock bluffs and intact vegetated banks. Instream habitats include rocky runs and pools of various depths and velocities and abundant wide riffles throughout. In 2018, a highly diverse and trophically balanced fish community was collected, with over 1,000 individuals present; however, no pollution intolerant species were found (likely due to the moderately elevated conductivity). Of the 22 species gathered in 2018, 16 of them have also been collected downstream (roughly 1.5 miles below this location) at the historic BF15 fish community site below the Mason Farm WWTP.

Year	Bioclassification
<b>BF147</b>	
2018	Good
<b>BF15</b>	
2013	Fair
<b>BB53</b>	
2003	Fair

Notwithstanding its urban nonpoint source pollution influences, this segment of Morgan Creek is supporting a robust and balanced assemblage of fish at this location, resulting in a Good rating.

In contrast, the downstream fish community site, BF15, located just below the WWTP has been rated Fair on three occasions in 1998, 1999 and 2013.

Morgan Creek [AU# 16-41-2-(5.5)b] from Meeting of the Waters Creek to Chatham County SR 2726 (Old Farrington Rd.) is classified as Water Supply-IV (WS-IV) as Morgan Creek drains to Jordan Lake, also WS-IV. This segment of Morgan Creek is currently (2022 IR) listed as impaired or exceeding criteria due to historic benthic macroinvertebrate community ratings at BB53 and BB96 and a 2013 fish community rating at BF15 (*Table 6-42*).

The two benthic community stations in this segment have been rated as Fair or Poor since the late 1980's. Station BB53 was last assessed in 2003 and received a Fair bioclassification. Fish community station BF15 is co-located with BB53 at SR 1900 (Old Mason Farm Rd.) about 0.7 miles downstream of the Mason Farm WWTP.

The habitat was described in 2013 as a well-shaded channel surrounded by wide riparian zones but hydrologically flashy due to development upstream. In 2013, the biologists reported high conductivity, 22 species of fish but a very skewed trophic structure (94% insectivores and 3% omnivores + herbivores) and a very high percentage of tolerant fish. It was suggested that the proximity to backwaters of Jordan Reservoir influenced species diversity, especially that of the sunfishes. Based upon all the water quality and fish community data collected, this stream has consistently been rated as Fair in 1998, 1999 and 2013 and suggests, given the impaired status, that future monitoring should be done about every 10 years.



There are some significant changes in the instream ambient water quality in Morgan Creek upstream and downstream of the Mason Farm WWTP.

Morgan Creek [AU# 16-41-2-(5.5)a] from Orange County SR 1919 to the confluence with Meeting of the Waters creek is currently listed as not rated (category 3a) due to elevated fecal coliform bacteria (FCB) concentrations at station B3899180, upstream of the WWTP ([Table 6-42](#)). The 2022 IR mean was 844 cfu/100mL, twice as high as the downstream station B3900000 (420 cfu/100 mL) below the Mason Farm WWTP ([Table 6-44](#)). The 14 MDG WWTP contributes additional flow to the stream, which likely dilutes the FCB concentrations ([Figure 6-96](#)). The FCB concentrations exceeded the 400 cfu/100 mL water quality standard 28.3% of the time and the geometric mean was 229 cfu/100 mL. A 5-in-30 assessment would be needed in order to give Morgan Creek an official use support rating. Due to limited resources, DWR prioritizes class B, primary recreational waters for this assessment. For more information on how waters are assessed for fecal coliform bacteria see section 2.5.4. The fecal coliform bacteria five-year mean concentrations at station B3899180 have not varied much over the last 20 years ranging between about 700 and 800 cfu/100ml ([Figure 6-96](#)). When the FCB data is separated by flow, the high flow mean concentration (1,204 cfu/100 mL) is higher than the middle and low flow concentrations (777 and 331 cfu/100 mL respectively) ([Figure 6-97](#)). The 777 cfu/100 mL mean FCB concentration for the middle/normal flow is still very high. This data shows there is a considerable need to control stormwater runoff in the Morgan Creek watershed.

The instream turbidity concentrations at the two ambient stations were fairly similar over the last 20 years ([Figure 6-96](#)). The mean 2022 IR instream turbidity concentration at station B3899180 upstream of the WWTP was 15.9 NTU with 6.7% of the samples exceeding the 50 NTU water quality standard ([Table 6-44](#)). The maximum recorded reading for this time period was 147 NTU. Similar to FCB, when the data is separated by flow, the high flow mean turbidity concentration is much higher (30.6 NTU) than the medium and low flow concentrations (9.3 and 4.5 NTU, respectively) ([Figure 6-97](#)).

Figure 6-96: Five Year Average Fecal Coliform Bacteria, Turbidity and Conductivity Concentrations at Station B3899180 and B3900000 in Morgan Creek with Stream Flow at USGS Gage 02097517.

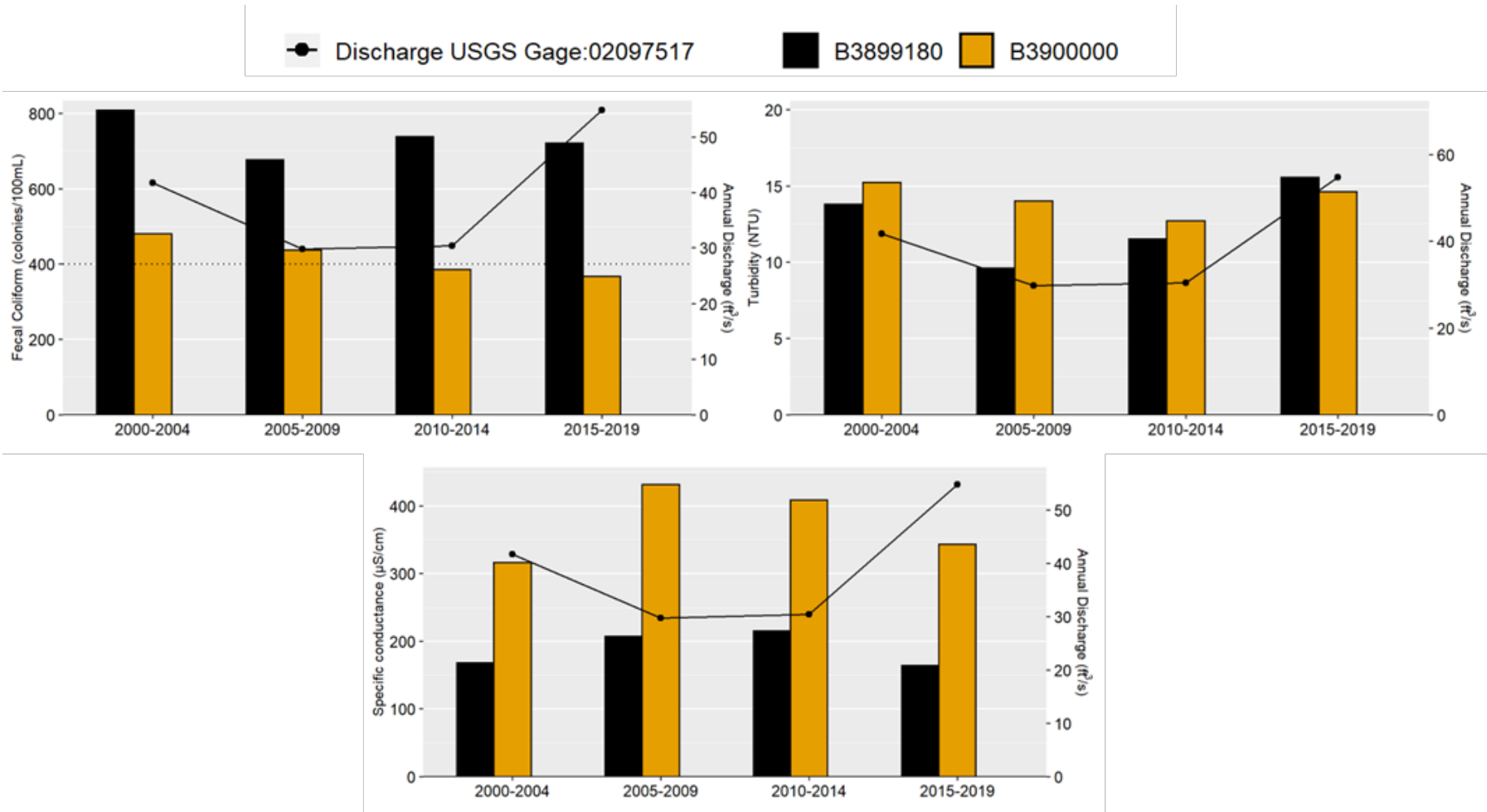
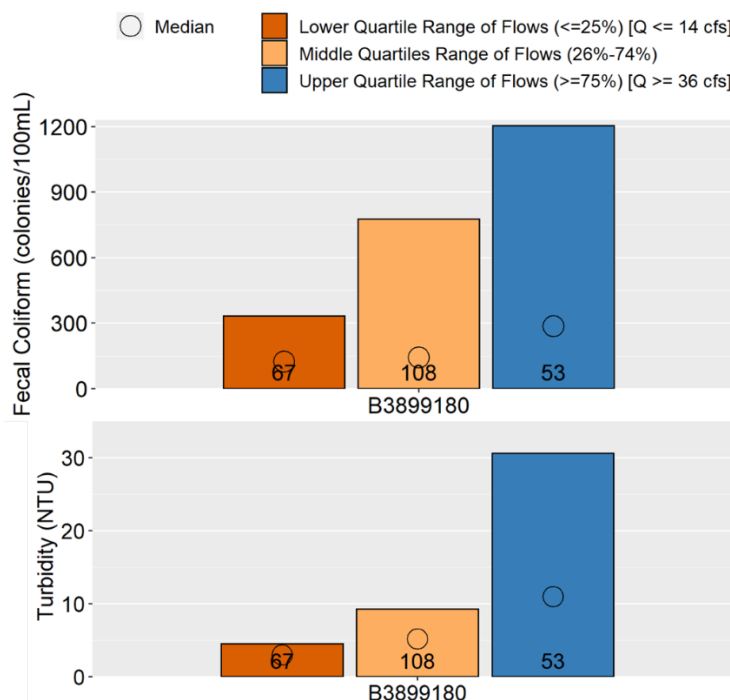


Figure 6-97: Flow Separated Mean and Median Concentrations for Turbidity and Fecal Coliform Bacteria (2002-2020) at Station B3899180 in Morgan Creek and Co-located USGS Gage Station 02097517 (1991-2020).



(See section 6.3 for data analysis description. High flows  $\geq$  75<sup>th</sup> percentile; Medium flows between 26<sup>th</sup> and 74<sup>th</sup> percentile; Low flows  $\leq$  25<sup>th</sup> percentile at USGS Gage Station 02097517 (1991-2020).

Nitrogen and phosphorus nutrient concentrations are much lower upstream of the WWTP at station B3899180 than downstream of the WWTP at station B3900000 (Figure 6-98). The nitrogen species upstream vary from year to year (Figure 6-99). There are several single-family domestic wastewater permits that could potentially contribute some nutrients, mostly likely through baseflow. The conductivity at both stations is elevated which indicates a pollution source in the watershed, however the conductivity upstream at B3899180 is about half of instream concentration as downstream (Figure 6-96). The 2022 IR period concentration was 153  $\mu$ S/cm upstream versus 326  $\mu$ S/cm downstream (Table 6-44).

Elevated nutrient concentrations and loading to Jordan Lake is an issue throughout this NSW watershed. Instream TN increases significantly downstream of the Mason Farm WWTP. The 2022 IR mean TN concentration was 0.98 mg/L upstream at station B3899180 and rose to 3.54 mg/L downstream at station B3900000 (Table 6-44). The TN is made up of mostly NO<sub>x</sub> downstream of the treatment plan (Table 6-44, Figure 6-98 and Figure 6-99). This is very typical of watersheds with point source discharges. The elevated instream conductivity downstream of the discharge is also indicative of point source contributions (Table 6-44 and Figure 6-96). The total phosphorus instream concentrations are also substantially higher downstream of the WWTP with a 2022 IR mean of 0.15 mg/L downstream verse 0.05 mg/L upstream (Table 6-44 and Figure 6-98).

Figure 6-98: Five Year Average Total Nitrogen, Total Kjeldahl Nitrogen, Nitrate+Nitrite, and Total Phosphorus Concentrations at Station B3899180 and B3900000 in Morgan Creek with Stream Flow at USGS Gage 02097517.

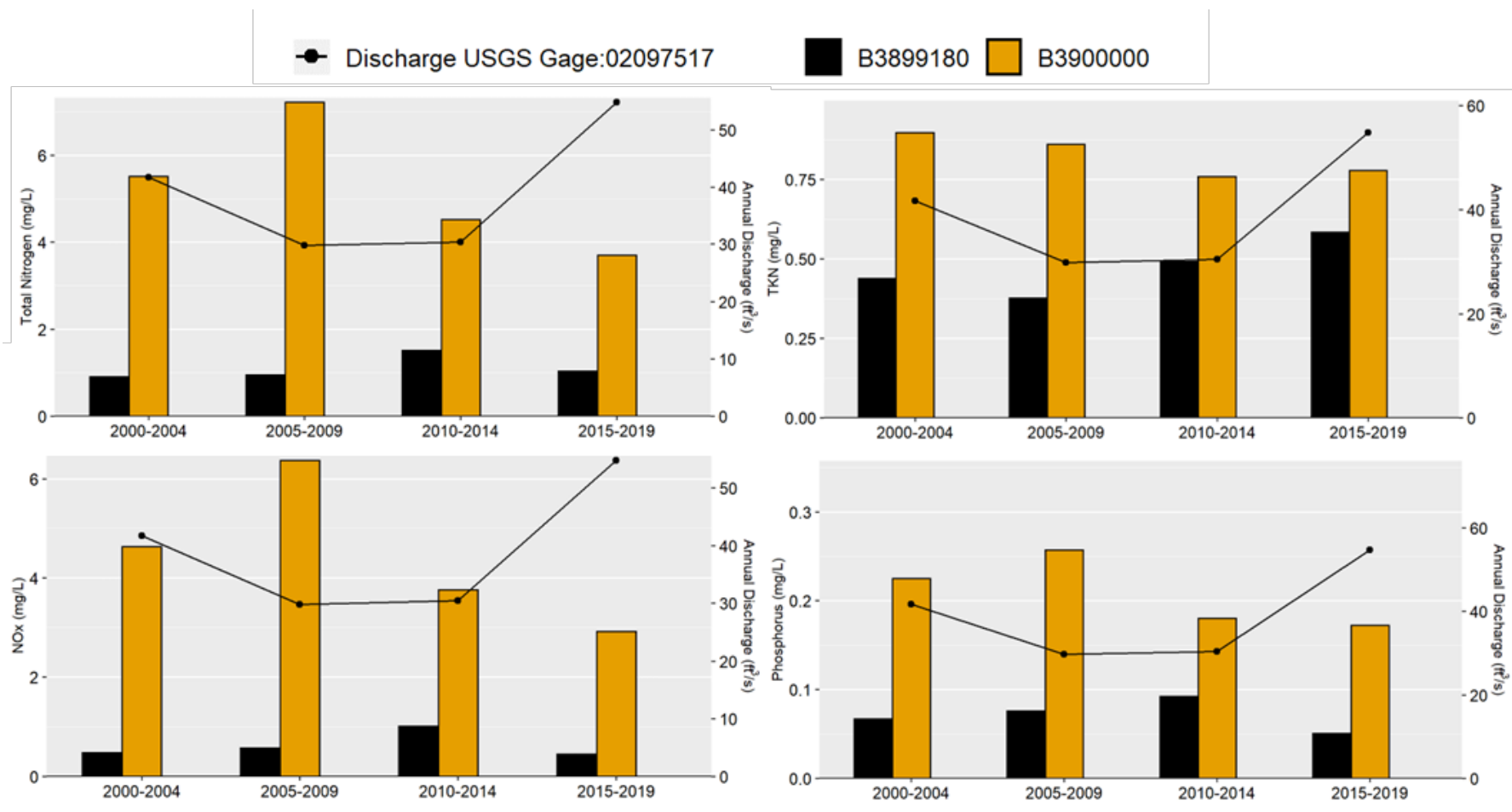
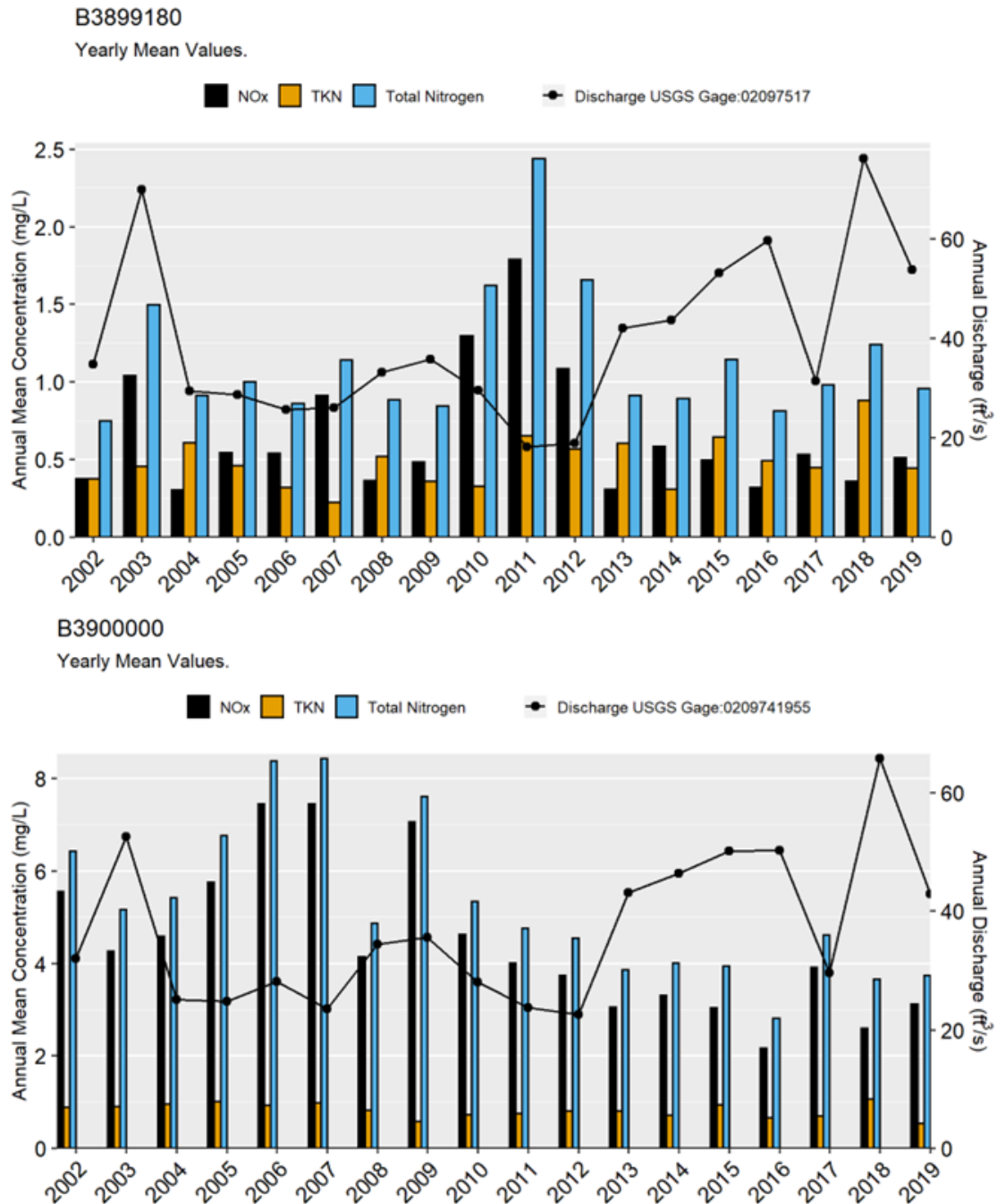


Figure 6-99: Morgan Creek Yearly Mean Nitrogen Constituent Concentrations at Station B3899180 and Station B3900000 with Corresponding USGS Flow.



DWR conducted a seasonal Mann-Kendall trend test at stations B3899180 and B3900000 for data collected from 2000-2019 and 2010-2019 (calculated at 95% confidence) and found a decreasing trend at both stations for NOx for 2010-2019. Additional declining trends were seen at B3900000 for TP (2000-2019), NOx (2000-2019), TKN (nonseasonal 2000-2019) and for NH3 (2010-2019 and nonseasonal 2000-2019)

(Table 6-44). Given the partial implementation of the Jordan Lake NSW rules and the many actions that have been taken to reduce nitrogen and phosphorus in the Jordan Lake watershed since about 2010, it is not surprising to see decreasing trends at either of these stations.

Ambient water quality monitoring station B3900000 in Morgan Creek is part of a special study on 1,4-dioxane in the Cape Fear River Basin. All 34 samples tested for 1,4-dioxane between 2018 and 2023 were below the PQL of 1 µg/L (non-detect). More information on 1,4-dioxane and other emerging contaminants can be found in Chapter 2 (section 2.12) and chapters 12 (PFAS) and 13 (1,4-dioxane).

The Orange Water and Sewer Authority (OWASA) 14 MGD [Mason Farm WWTP \(NC0025241\)](#) lies within the Upper New Hope Arm of Jordan Lake and is subject to the Jordan Lake nutrient strategy (15A NCAC 02B .0270). The Upper New Hope Arm of Jordan Lake was meeting the overall lake arm TN (434,170 lbs/yr) and TP (32,919 lbs/yr) point source load allocation in 2022. Mason Farm WWTP TN effluent limits took effect January 2021; however, they have been below this load since 2015 (Table 6-46). According to the 2020 [permit fact sheet](#), their average discharge volume between January 2014-June 2018 was 6.08 MGD with a maximum of 27.354 MGD. Their average effluent TN and TP concentrations were 6.98 and 0.44 mg/L respectively (NC DEQ, 2020b). Mason Farm WWTP treats both domestic and industrial waste (50/50) and should utilize their pretreatment program to ensure that emerging compounds are not coming from their significant industrial users. Jordan Lake as well as much of the Haw River and Cape Fear River below Jordan dam are water supply waters and need to be protected for this critical designated use.

For more information on point source contribution to Jordan Lake, see the point source discussion section below and the Jordan Lake point source loading chart in Subbasin Chapters Appendix.

*Table 6-46: Orange Water and Sewer Authority Mason Farm Wastewater Treatment Facility Annual Total Nitrogen and Total Phosphorus Jordan Lake Allocation and their Yearly Load between 2019 and 2022.*

Mason Farm WWTP NC0025241	Allocation lbs/yr	Delivery Factor	2019 lbs/yr	2020 lbs/yr	2021 lbs/yr	2022 lbs/yr
<b>Total Nitrogen</b>	134,375	63%	108,131	96,235	101,203	109,214
<b>Total Phosphorus</b>	10,188	47%	2,262	1,143	1,224	1,958

Jordan Lake nutrient strategy (15A NCAC 02B .0270)

Wilson Creek (AU# 16-41-2-6) from the source to Morgan Creek will likely be listed as impaired on the 2024 IR due to a 2021 Fair bioclassification at station BB545. Wilson Creek (also called Obie or Obey Creek) at Fan Branch Trail was sampled as a training exercise in February 2021 and received a Fair bioclassification. Wilson Creek is a tributary to Morgan Creek and drains suburban neighborhoods adjacent to US Hwy 15/501 N near the Orange/Chatham County line. The watershed includes Fan Branch which drains the large Southern Village development. Within the sampling reach, Wilson Creek is severely down cut with areas of massive lateral bank erosion. Instream habitat lacks the typical Slate Belt composition of boulder and cobble, instead consisting mostly of gravel and sand. The current bioclassification is typical of urban watersheds in the area.

#### 6.6.6.4 Northeast Creek

The headwaters of Northeast Creek [AU# 16-41-1-17-(0.3), 16-41-1-17-(0.7)a, 16-41-1-17-(0.7)b1, 16-41-1-17-(0.7)b2] originate in Durham County at the crossroads of South Miami Blvd and Angier Ave. The subwatershed encompasses the new I-885/NC Hwy 147 interchange. The creek flows through the southeastern portion of the City of Durham. Northeast Creek continues to flow in a southwesterly direction into Chatham County and drains into the New Hope arm of Jordan Lake. Parts of Apex, Cary and Wake County also drain to the lower portion of Northeast Creek. The Northeast Creek watershed lies in the geological Triassic basin, which has highly erodible soils which lead to sedimentation that impairs water quality and aquatic habitat. Triassic soils are also poorly drained with low permeability, reducing infiltration and reducing the performance of stormwater control measures that rely on infiltration (City of Durham, 2013).

Portions of Northeast Creek became impaired or exceeding criteria for turbidity, fecal coliform bacteria, copper and zinc (*Table 6-42*). There are also elevated levels of nutrients in Northeast Creek contributing to the elevated biological productivity in Jordan Lake.

There are three instream water quality monitoring stations in this subwatershed (*Table 6-43* and *Table 6-47*). There is an approximate 4-year data gap (2016-2019) in the upper station B3300000 dataset. The station was eliminated in November 2015 due to Durham County withdrawing from the monitoring coalition. In 2020, the City of Durham’s stormwater program recognized the need for the data at this station and funded UCFRBA to reinitiate monitoring at B3300000. No biological samples have been collected in this subwatershed since the late 1990’s. Station B3660000 is co-located with a USGS gage (0209741955) and is used to assess how stream flow impacts water quality using 2002-2019 water quality data. Station B3670000 is the water quality station closest to Jordan Lake and captures drainage from Kit Creek.

*Table 6-47: Northeast Creek Instream Ambient Monitoring Stations with Monitoring Period.*

Station	Northeast Creek Sample Location	AU #	Monitoring Program	Monitoring Period
<b>B3300000</b>	At SR 1102/Sedwick Rd near RTP - ~0.5 miles upstream of WWTP	16-41-1-17-(0.7)a	UCFRBA	4/1/2000-10/20/2015 & 3/2020-present (No data for Nov. 2015 – Feb. 2020)
<b>B3660000</b>	At SR 1100/Grandale Dr near Nelson - ~1.3 miles downstream of WWTP	16-41-1-17-(0.7)b1	AMS	Started 2/12/1969
<b>B3670000</b>	At SR 1731/O’Kelly Church Rd Durham – ~3.3 downstream of WWTP & ~2.5 upstream of Jordan Lake arm	16-41-1-17-(0.7)b2	UCFRBA	Started 4/1/2000

There are several clusters of single-family NPDES permits throughout the subwatershed. The only major wastewater discharger is the 12 MGD Durham County Triangle WWTP (NC0026051) which discharges into Northeast Creek between the upper two ambient monitoring stations. The furthest downstream station, B3670000 is used to assess the water quality of this system prior to entering the New Hope arm of Jordan Lake.

The 2019 land use has changed substantially at station B3670000 since 2001. This station captures a large portion of the subwatershed entering Jordan Lake. Development increased from 41 to 58%, with forest declining from 46 to 31%, respectively. The impervious cover in 2019 is estimated to be 22.2%, which is up from 13.4% in 2001.

In 2003, the EPA approved a fecal coliform bacteria TMDL for an 8.4 mile segment of Northeast Creek from Hwy 55 to a point 0.5 miles downstream of Panther Creek [AU#s 16-41-1-17-(0.7)a, 16-41-1-17-(0.7)b1, 16-41-1-17-(0.7)b2] ([NC DENR, 2003](#)). See [Table 6-48](#) for the required fecal coliform bacteria reductions needed by sources identified in the subwatershed in order to meet instream water quality criteria.

The sources of FCB were from both point and nonpoint sources in the subwatershed. Point sources identified were the NPDES MS4 stormwater and not the wastewater treatment facility. At the time of the TMDL, the only MS4 areas were located in Durham County. Three entities have NPDES stormwater permit requirements: the City of Durham and NCDOT (Phase I permit) as well as Durham County (Phase II permit).

The nonpoint sources identified in Northeast Creek include wildlife, livestock (land application of agricultural manure and grazing), urban development (stormwater runoff, including sources from domestic animals), failing septic systems and sewer line systems (illicit connections, leaky sewer lines, and sewer system overflows). The TMDL estimated that about 10% of the urban FCB load was from domestic animals. DWR recommends that the local government educate the public on the importance of picking up animal waste to reduce the loading from the urban environment. For additional information see the [Northeast Creek watershed fecal coliform bacteria TMDL](#).

*Table 6-48: Northeast Creek Fecal Coliform Bacteria TMDL Required Load Reductions.*

Fecal Coliform Bacteria Sources	Reduction (%)
<b>Point Source</b>	
Stormwater NPDES MS4	92
NPDES Wastewater	0
<b>Nonpoint Source</b>	
High Intensity Development*	92
Low Intensity Development*	94
Herbaceous Lands	90
Wildlife	0

\*Urban development without MS4;  
MS4 – Municipal Separate Storm Sewer System.

The FCB data collected for the 2022 IR assessment (2016-2020) show that the instream concentrations in all three segments of Northeast Creek remain elevated ([Table 6-44](#)). Caution should be taken when comparing B3300000 due to samples only representing a single year (2020), however all three stations had geometric means of greater than 200 cfu/100 mL and 20% or more of the samples were greater than 400 cfu/100 mL ([Table 6-49](#)).

Figure 6-100 shows that the five-year FCB means have declined at Station B3670000 over the last 20 years from about 900 to 500 cfu/100 mL, while at station B3660000, there has been an increase since the 2005-2009 five-year period from about 300 to 600 cfu/100 mL. The five-year mean has declined at all three stations since the 2000-2004 period (Figure 6-100). Flow separated data from 2002-2019 for station B3660000 shows high instream concentration at both low and high flow with a mean concentration of 428 and 960 cfu/100 mL, respectively (Figure 6-101). DWR conducted a seasonal Mann-Kendall trend test at stations B366000 and B3670000 for FCB data collected from 2000-2019 and 2010-2019 (calculated at 95% confidence) and found a significant increase in FCB concentrations at station B366000 for 2010-2019 and at B3670000 for the period between 2000 and 2019 (Table 6-44).

Table 6-49: Northeast Creek Summary Water Quality Data for Fecal Coliform Bacteria and Turbidity for the 2022 IR Period.

Northeast Creek Stations	Fecal Coliform Bacteria (cfu/100 mL)					Turbidity				
	n Samples	Mean	Median	Min	Max	75th Percentile	% > 400	Geo-mean	Mean (NTU)	% > 50
B3300000*	10	642	300	45	3,400	585	20%	294	76.7	70%
B3660000	49	603	200	39	11,000	535	33%	264	42.4	24%
B3670000	59	557	200	7	9,400	440	29%	224	42.8	19%

\*Caution should be used when comparing this station since only 10 samples were collected in 2020.

Figure 6-100: Five Year Average Fecal Coliform Bacteria Concentrations at Stations B3300000, B3660000 and B3670000 in Northeast Creek with Stream Flow at USGS Gage 0209741955. (Note the 2015-2019 period does not align with the 2022 IR period. Station B330000 only has a single year of data for 2015 in the last 5-yr period).

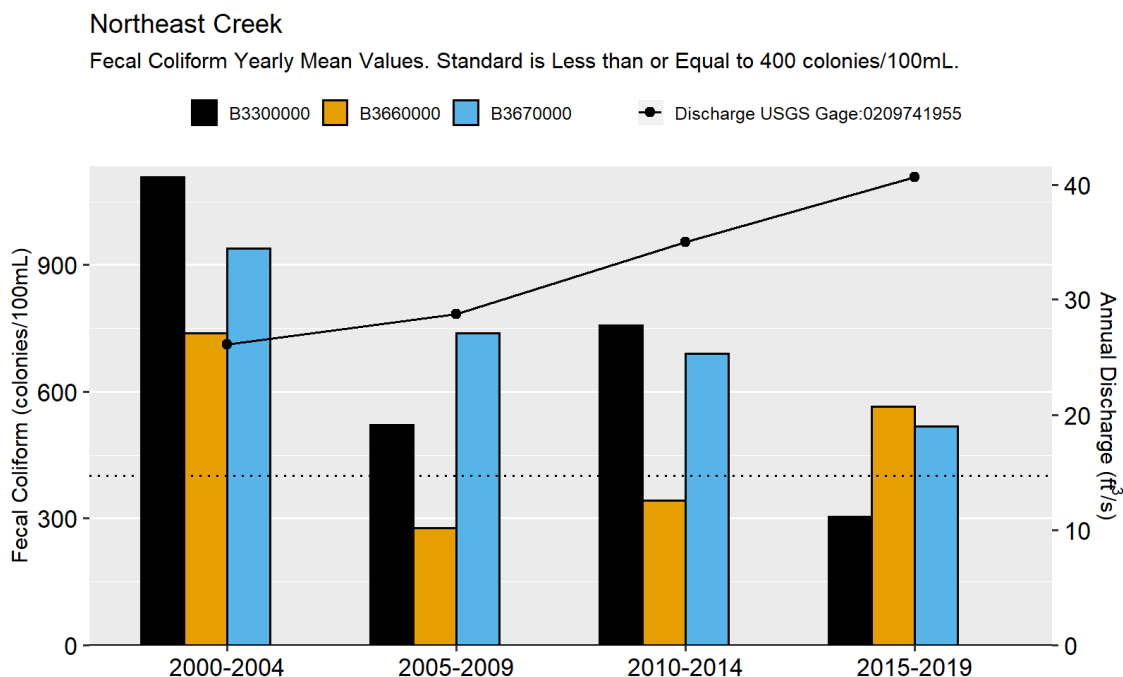
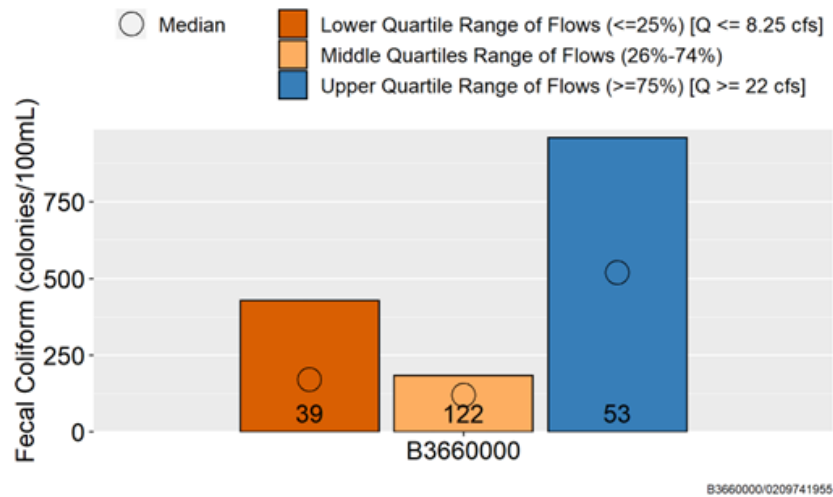


Figure 6-101: Flow Separated Mean and Median Concentration for Fecal Coliform Bacteria at Station B3660000 in Northeast Creek Co-located USGS Gage Station 0209741955.



See section 6.3 for data analysis description. High flows  $\geq 75^{\text{th}}$  percentile; Medium flows between  $26^{\text{th}}$  and  $74^{\text{th}}$  percentile; Low flows  $\leq 25^{\text{th}}$  percentile at USGS Gage Station 0209741955. Flow estimate based on 1991-2020 data. (L=428/170, M=184/120, H=960/520)

All three segments of Northeast Creek are listed as impaired on the 2022 IR under category 4t (impaired with TMDL) (*Table 6-42*). Implementation of BMPs to address the sources identified in the TMDL including stormwater measures to reduce runoff, increase infiltration, repair failing infrastructure such as leaky collection systems and failing septic systems, public education programs on pet waste collection, proper operation of single-family WW and septic systems and disconnection of downspouts are just a few of the many actions that are needed in this watershed to help achieve the FCB TMDL reduction requirements (*Table 6-48*).

To address the FCB impairment and TMDL, the City of Durham’s Stormwater Quality group is funding a cost-share project for qualifying residential property owners in the Northeast Creek watershed that are interested in replacing their onsite wastewater treatment system (e.g., septic system, discharging sand filter system) with a connection to the City of Durham’s sewer system. This cost-share project covers the cost of one or more city and county sewer fee(s) depending on the eligibility of each applicant. The goal of the Northeast Creek Septic to Sewer cost-share project is to reduce fecal coliform bacteria coming from failing onsite wastewater treatment systems in the Northeast Creek watershed while assisting homeowners in the city limits. There are an estimated 35 to 40 systems eligible in the Northeast Creek watershed. For more information about this cost-share opportunity or for information on septic system maintenance please visit their [website](#).

As with FCB, all three monitored segments of Northeast Creek from Hwy 55 to a point 0.5 miles downstream of Panther Creek are currently (2022 IR) listed as impaired or exceeding criteria for turbidity (*Table 6-42*). The 2022 IR turbidity mean concentrations and percent exceedance of the 50 NTU standard were 76.7 NTU and 70% at B3300000 (upstream station), 42.4 NTU and 24% at B3660000 (middle station)

and 42.8 NTU and 19% at B3670000 (downstream station), respectively ([Table 6-49](#)). The data included in the 2022 IR for station B330000 is only for March-December 2020 (n=10). This limited dataset is likely skewing the results for this station. The upper Northeast Creek was previously listed as impaired based on the older dataset. DWR conducted a Mann-Kendall trend test at station B3660000 and B3670000 for data collected from 2000-2019 and 2010-2019 (calculated at 95% confidence) and found a significant increasing (non-seasonal) trend at B3660000 for 2010-2019 and an increasing seasonal trend at B3670000 for the same time period ([Table 6-44](#)).

A flow separated analysis from 2002-2019 for station B3660000 with a co-located USGS gage shows high instream concentration at high flow with a mean and median turbidity concentration of 59.7 and 50 NTU, respectively ([Figure 6-104](#)). The middle/normal and low flows are similar and indicate that the instream water quality standard of 50 NTU is likely met in Northeast Creek when flows are below 22 cfs. According to BIMS, the average stream flow near B3660000 was estimated to be 20 cfs with a summer 7Q10 of zero cfs and a winter 7Q10 of 0.5 cfs.

Total Suspended Solids (TSS) were also collected and show a similar instream concentration pattern as turbidity ([Figure 6-102](#), [Figure 6-103](#), and [Figure 6-104](#)). It is important to collect TSS data as part of the monitoring programs in Northeast Creek as TSS data would be needed to develop a TMDL. The turbidity and TSS data indicate that the source of the elevated instream concentrations contributes to the loading in Northeast Creek during high flow or storm events. Stormwater runoff is likely carrying sediment into surface waters and scouring stream banks during high flow events. Much like reducing the FCB load, BMPs addressing stormwater runoff and improved infiltration will help reduce the overall loading to this stream.

The Northeast Creek copper and zinc impairments are based on a legacy total metals assessment which added portions of Northeast Creek to the 2008 impaired waters list [303(d)]. North Carolina adopted new dissolved metals water quality standards in 2014 ([15A NCAC 02B .0211](#)). *When resources allow, Northeast Creek should be reassessed for dissolved metals.* A likely source of copper in urban streams is from motor vehicle brake pad dust. In 2015, EPA and the auto industry signed an agreement to reduce the use of copper and other materials in brake pads in an effort to decrease the runoff of these materials from roads into surface waters ([EPA Copper-Free Brake Initiative](#)). Copper and zinc from stormwater runoff can affect fish, amphibians, invertebrates and plants.

As of 2022, no data is available in the upper 5.5 miles of Northeast Creek [AU# 16-41-1-17-(0.3)] from the source to Hwy 55. There are likely significant stormwater impacts from this highly urbanized/commercial portion of the watershed and the instream conditions are likely to be similar to the rest of the watershed which are highly impacted and impaired for FCB and turbidity.

Figure 6-102: Five Year Average Turbidity Concentrations at Stations B3300000, B3660000 and B3670000 in Northeast Creek with Stream Flow at USGS Gage 0209741955. (Note the 2015-2019 period does not align with the 2022 IR period. Station B3300000 only has a single year of data for 2015 in the last 5-yr period).

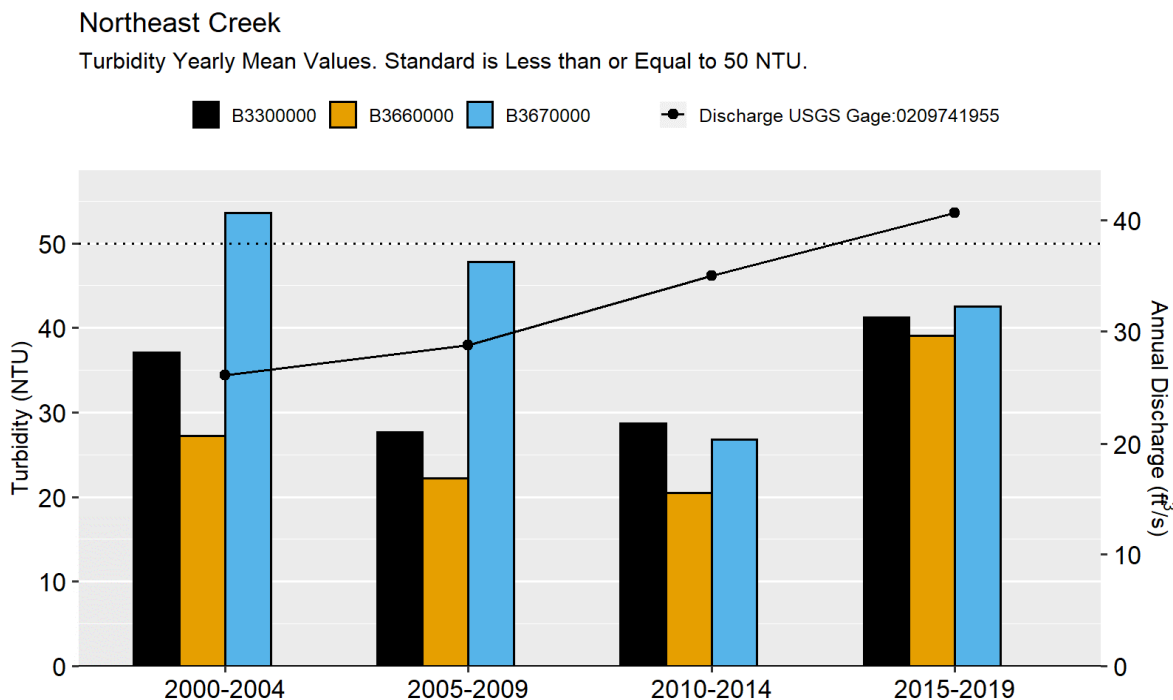


Figure 6-103: Five Year Average Total Suspended Solids at Station B3660000 in Northeast Creek with Stream Flow at USGS Gage 0209741955.

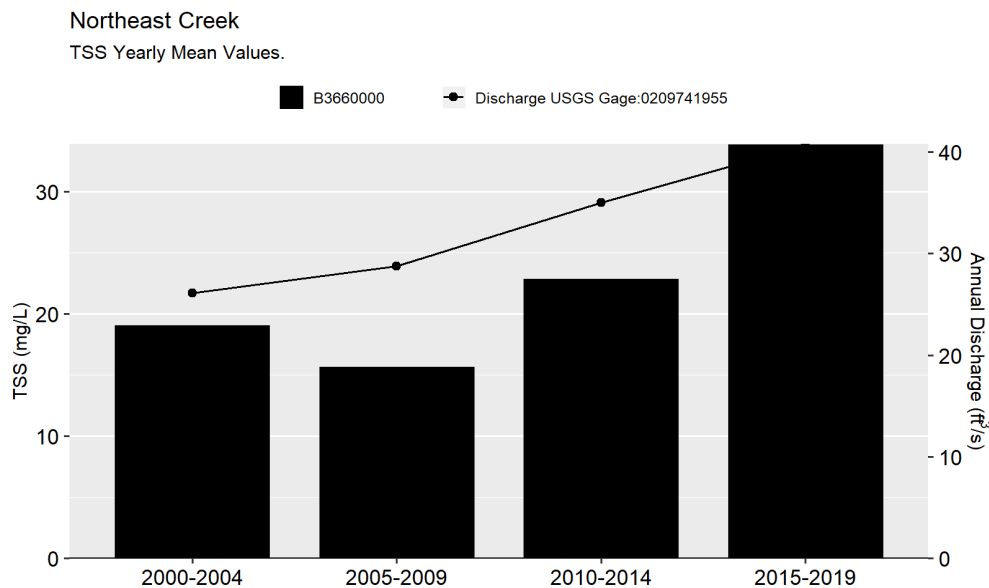
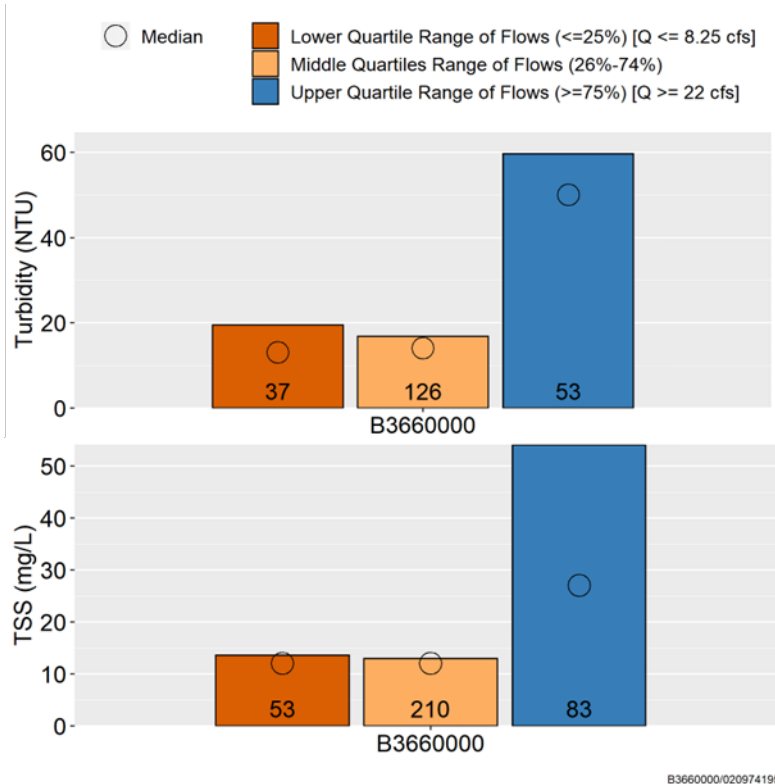


Figure 6-104: Seventeen Year (2002-2019) Flow Separated Mean Concentration for Turbidity and Total Suspended Solids at Station B3660000 in Northeast Creek.



See section 6.3 for data analysis description. High flows  $\geq 75^{\text{th}}$  percentile; Medium flows between  $26^{\text{th}}$  and  $74^{\text{th}}$  percentile; Low flows  $\leq 25^{\text{th}}$  percentile at USGS Gage Station 0209741955. Flow estimate based on 1991-2020 data. (Turbidity: L=19.5/13, M=16.8/14, H=59.7/50) (TSS: L=12.9/12, M=13.5/12, H=54/27)

Northeast Creek [AU# 16-41-1-17-(0.7)a] from Hwy 55 to Durham County Triangle WWTP is listed (2022 IR) as impaired or exceeding criteria for turbidity, FCB and total copper. The water quality data from ambient monitoring station B3300000 (located at Sedwick Dr) indicate a potential low dissolve oxygen issue with 6.7% (1 of 15) of the readings below the instantaneous state standard of 4 mg/L and was listed as data inconclusive (category 3a) on the 2022 IR (*Table 6-42*). The mean and median concentrations for the 2022 IR period were 6.59 and 6.40 mg/L, respectively, with a minimum record of 3.90 mg/L. This segment of Northeast Creek was previously listed as impaired on the 2020 IR (4c) with 25% of the samples collected between 2014 and 2015 (n=32) below the standard. New data collected from 2020 forward will allow for a better assessment of the standard going forward.

The instream DO concentration increased downstream at station B3660000 and had a 2022 IR mean concentration of 7.55 mg/L with a minimum recorded reading of 4.86 mg/L. The 12 MGD Durham County Triangle WWTP discharges between the two stations and augments the stream flow, improving the instream DO condition during low flow periods.

As previously stated, this segment is also impaired for total copper based on legacy data. Station B3300000 should be resampled for dissolved metals to verify or remove the legacy impairment (2022 IR category 5) at this location.

Northeast Creek [AU# 16-41-1-17-(0.7)b1] from Durham County Triangle WWTP to Kit Creek is listed (2022 IR) as impaired or exceeding criteria for turbidity, FCB, and total zinc based on data collected at station B3660000 located about 1.3 miles downstream of the Durham County Triangle WWTP.

As previously stated, this segment is impaired for total zinc based on legacy data. DWR has started a dissolved metals assessment at station B3660000. As of 2020, eight samples were assessed with no excursions of the dissolved zinc criteria; however, one of eight (12.5%) exceeded the acute dissolved copper criteria and two of eight (25%) exceeded the chronic dissolved copper criteria. A use support determination on this segment of Northeast Creek should be available for the 2024 IR (data window is 2018-2022). The currently available data however indicate elevated dissolved copper does occur and likely impacts the aquatic ecosystem inhabiting this stream system.

The 12 MGD Durham County [Triangle WWTP permit \(NC0026051\)](#) was renewed on October 1, 2022. This treatment plant is located in the Upper New Hope arm of Jordan Lake and is subject to the Jordan Lake nutrient strategy (15A NCAC 02B .0262). The Upper New Hope arm of Jordan Lake is meeting the lake arm overall TN (434,170 lbs/yr) and TP (32,919 lbs/yr) point source load allocation. In 2022, Triangle WWTP discharged only 67% of their TN load of 111,207 lbs/yr and 94.6% of their TP allocation of 8,432 lbs/yr.

*Table 6-50: Durham County Triangle Wastewater Treatment Plant Annual Total Nitrogen and Total Phosphorus Jordan Lake Allocation and their Yearly Load between 2019 and 2022.*

Triangle WWTP NC0026051	Allocation lbs/yr	Delivery Factor	2019 lbs/yr	2020 lbs/yr	2021 lbs/yr	2022 lbs/yr
<b>Total Nitrogen</b>	111,207	96%	52,899	37,421	44,531	74,871
<b>Total Phosphorus</b>	8,432	97%	6,315	8,019	3,574	7,973

Jordan Lake nutrient strategy (15A NCAC 02B .0270)

According to the 2022 NPDES [permit fact sheet](#) the average flow between January 2018-February 2022 was 4.17 MGD with a maximum flow of 12.77 MGD. Their average effluent TN and TP concentrations were 4.39 and 0.42 mg/L respectively (NC DEQ, 2022c). Triangle WWTP will monitor their effluent for 1,4-dioxane monthly and various PFAS quarterly after EPA publishes a method [permit section A.(1.) and A.(11.) and A.(12.); NC DEQ, 2022d].

For more information on point source contribution to Jordan Lake, see the point source discussion section below and the Jordan Lake point source loading chart in Chapter 6 Appendix.

Northeast Creek (ambient water quality monitoring station B3660000) is part of a special study on 1,4-dioxane in the Cape Fear River basin. All 38 samples tested for 1,4-dioxane between 2018 and 2023 were below the PQL of 1 µg/L (non-detect). More information on 1,4-dioxane and other emerging contaminants can be found in Chapter 2 (section 2.12) and chapters 12 (PFAS) and 13 (1,4-dioxane).

The elevated nutrients in this section of Northeast Creek will be discussed in detail below.

Northeast Creek [AU# 16-41-1-17-(0.7)b2] from Kit Creek to a point 0.5 miles downstream of Panther Creek is listed (2022 IR) as impaired or exceeding criteria for turbidity, fecal coliform bacteria, total copper, and total zinc based on data collected at station B3670000 about 3.3 miles downstream of the Durham County Triangle WWTP. As previously stated, this segment is also impaired for total copper and zinc based on legacy data. Station B3670000 should be resampled for dissolved metals to verify or remove the legacy impairment (2022 IR category 5) at this location.

Elevated nutrient concentrations and loading to Jordan Lake is an issue throughout this NSW watershed. Instream TN concentration increases significantly downstream of the Durham County Triangle WWTP. The 2022 IR mean TN concentration rose from 0.87 mg/L upstream at station B3300000 to 2.94 mg/L and 2.5 mg/L downstream at stations B3660000 and B3670000, respectively ([Table 6-44](#) and [Figure 6-105](#)).

The TN concentrations dropped substantially in 2005 and again in 2006 ([Figure 6-106](#) and [Figure 6-107](#)). TP concentrations dropped in 2008 ([Figure 6-106](#)). In June 2005, the Triangle WWTP completed an expansion and upgrade from a 6 MGD to a 12 MGD BNR treatment facility. TN was made up of mostly TKN upstream of the WWTP and NO<sub>x</sub> downstream of the treatment plant ([Table 6-44](#) and [Figure 6-107](#)). This is very typical of watersheds with point source discharges. The nitrogen species (NO<sub>x</sub> and TKN) breakdown at station B3670000 was very similar to B3660000, data not included, however the five-year mean concentration data showed how these two stations were similar to each other ([Table 6-44](#) and [Figure 6-105](#)).

The total phosphorus instream concentrations were also substantially higher downstream of the WWTP. The 2022 IR mean was 0.09 mg/L upstream versus 0.23 mg/L downstream ([Table 6-44](#) and [Figure 6-105](#)). The elevated instream conductivity downstream of the discharge is also indicative of point source contributions ([Table 6-44](#) and [Figure 6-108](#)).

DWR conducted a seasonal Mann-Kendall trend test at stations B3660000 and B3670000 for data collected from 2000-2019 and 2010-2019 (calculated at 95% confidence). Decreasing trends at station B3660000 were found for TP and NO<sub>x</sub> between 2010-2019 (likely attributed to the WWTP upgrade) and decreasing trends were noted for TKN and NH<sub>3</sub> for both time periods 2000-2019 and 2010-2019 ([Table 6-44](#)). At the station closest to the lake, B3370000, decreasing trends were found for TP and NH<sub>3</sub> only for the 2000-2019 time period ([Table 6-44](#)). Given the partial implementation of the Jordan Lake NSW rules and the many actions that have been taken to reduce nitrogen and phosphorus in the Jordan Lake watershed since about 2010, it is not surprising to see decreasing trends at either of these stations since 2000.

Figure 6-105: Five Year Average Total Nitrogen, NOx, Total Kjeldahl Nitrogen and Total Phosphorus Concentrations at Stations B3300000, B3660000 and B3670000 in Northeast Creek with Stream Flow at USGS Gage 0209741955.

(Note the 2015-2019 period does not align with the 2022 IR period. Station B3300000 only has a single year of data for 2015 in the last 5-yr period).

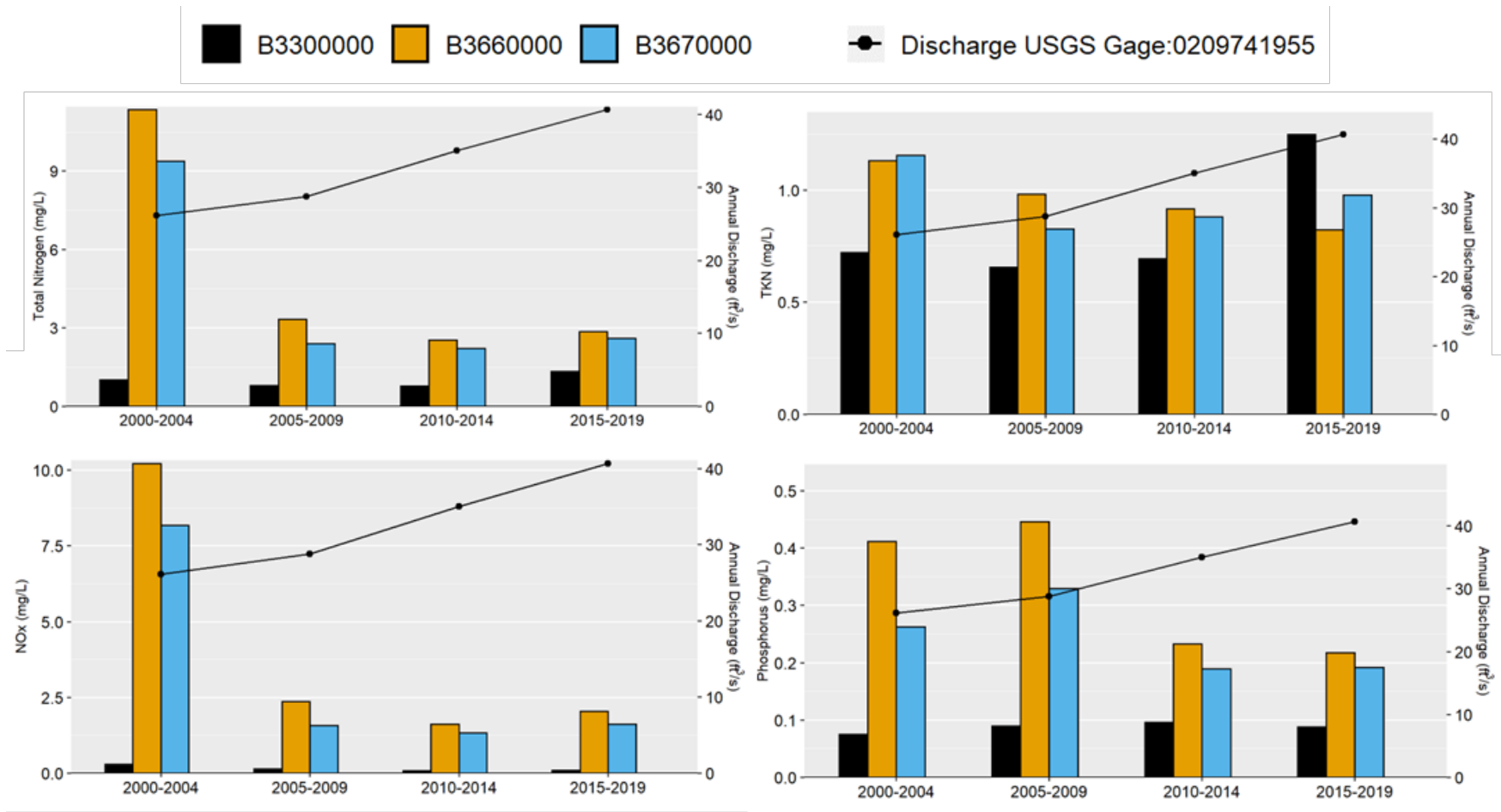


Figure 6-106: Yearly Mean and Median at Station 3660000 for Total Nitrogen, and Total Phosphorus Concentrations (1991-2020).

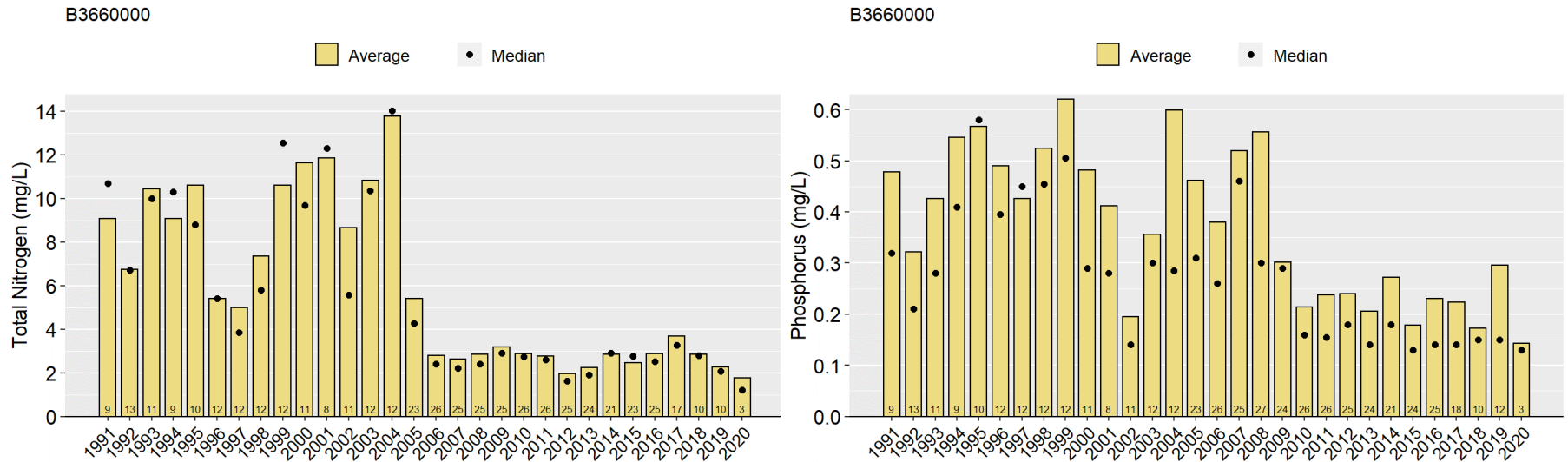
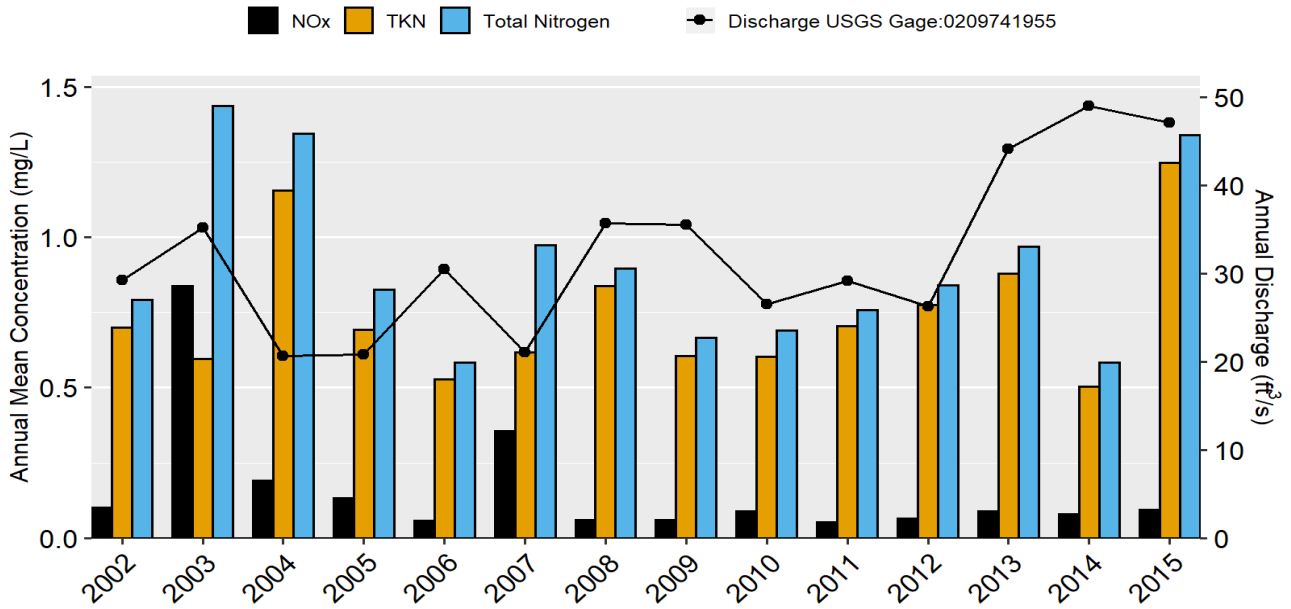


Figure 6-107: Northeast Creek Yearly Mean Nitrogen Constituent Concentrations at Stations B330000, Upstream of the WWTP and Station B3660000, Downstream of the WWTP, with Corresponding USGS

**B3300000**

Yearly Mean Values.



**B3660000**

Yearly Mean Values.

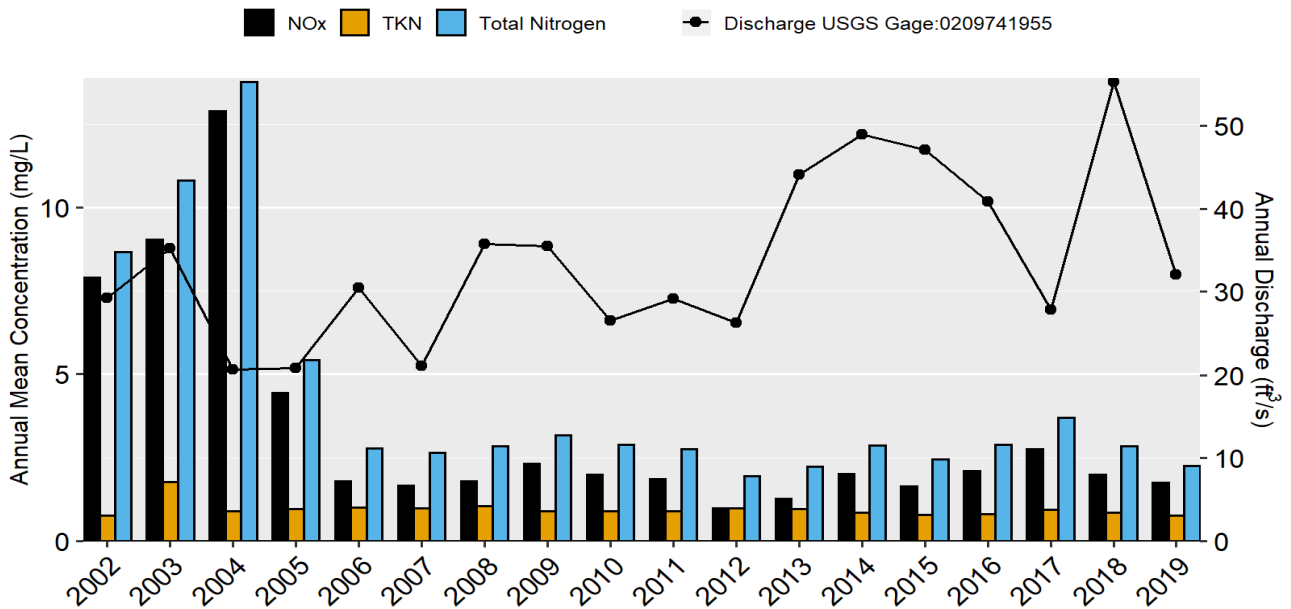
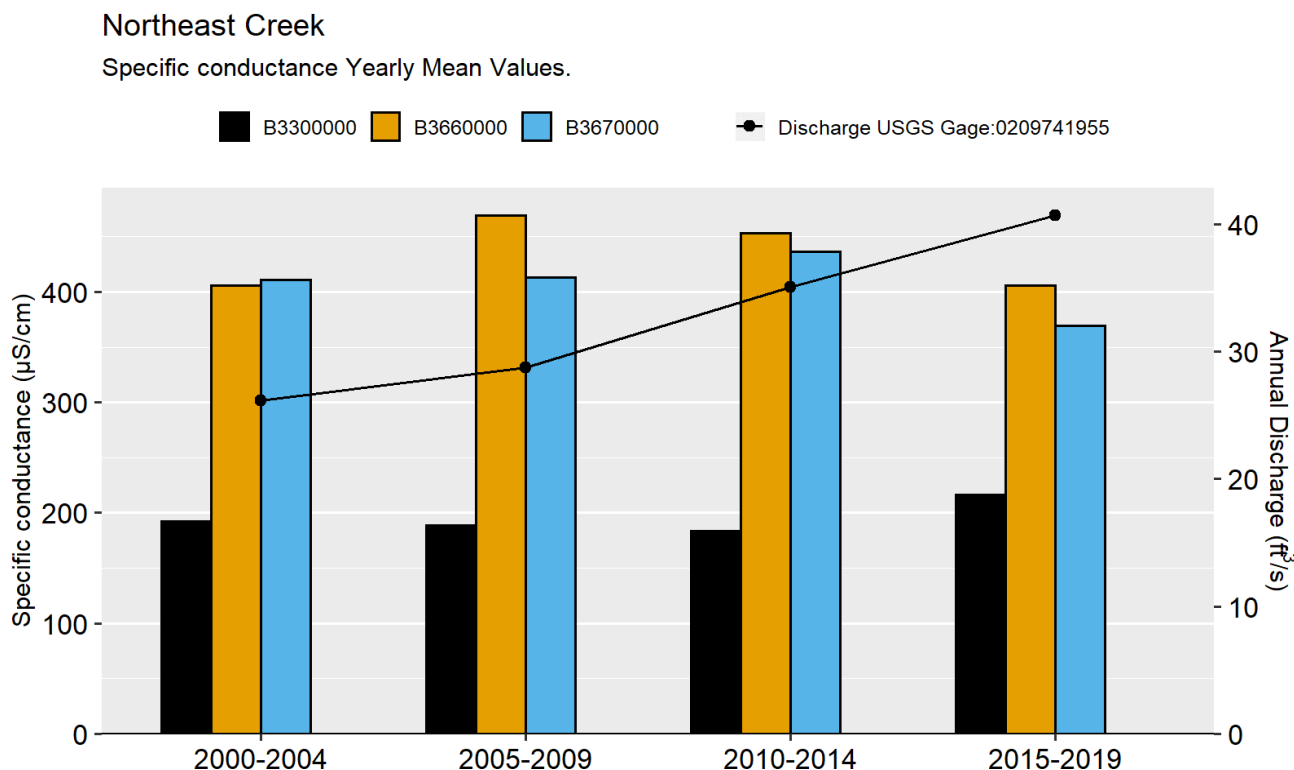


Figure 6-108: Five Year Average Conductivity Concentrations at Stations B3300000, B3660000 and B3670000 in Northeast Creek with Stream Flow at USGS Gage 0209741955. (Note the 2015-2019 period does not align with the 2022 IR period. Station B3300000 only has a single year of data for 2015 in the last 5-yr period).



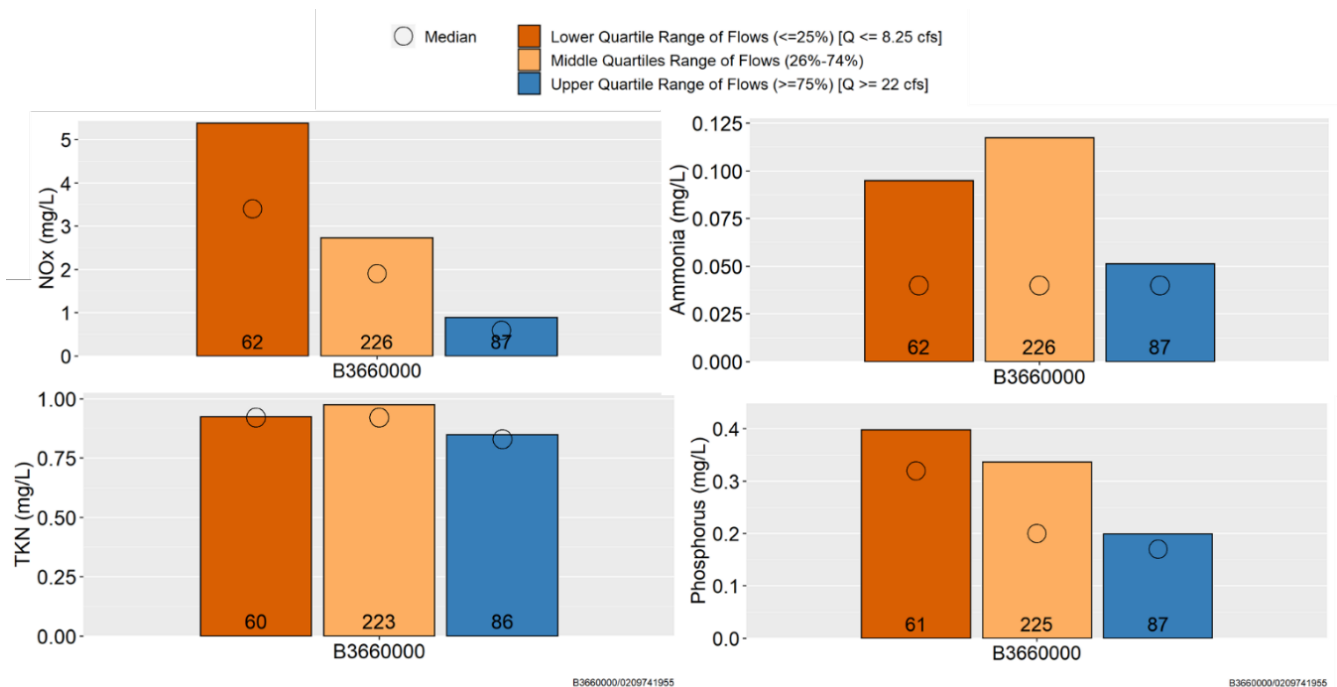
Instream nutrients were also assessed using the flow separated technique at station B3660000. The assessment revealed that the highest instream concentrations for NO<sub>x</sub> and TP occurred during the low-flow periods (bottom 25<sup>th</sup> percentile flow) when the majority of the water in the stream was from the WWTP (Figure 6-109). The low flow NO<sub>x</sub> mean and median were 5.38 and 3.4 mg/L, respectively, about six times higher in comparison to the high-flow periods (≥ 75<sup>th</sup> percentile) where the mean and median were 0.89 and 0.59 mg/L, respectively (Figure 6-109). The instream TP concentrations were about twice as high during low-flow periods versus high-flow periods with the mean and median concentrations of 0.4 and 0.32 mg/L at low flow and 0.20 and 0.17 mg/L at high flow, respectively (Figure 6-109). By contrast, TKN concentrations were consistent across the flow spectrum and NH<sub>3</sub> was highest during the normal flow range with a mean of 0.12mg/L (Figure 6-109).

The City of Durham’s Watershed Restoration group is responsible for watershed planning, existing retrofits, green stormwater infrastructure and public education and involvement. A [Northeast and Crooked Creek Watershed Improvement Plan](#) was completed in 2013. A watershed assessment and improvement plan provided a review of their water quality monitoring data, identified impacts and sources to watershed functions, and developed a comprehensive summary of potential projects throughout the watershed.

Panther Creek [AU# 16-41-1-17-3] from the source to Northeast Creek was assessed in 2017 and 2018 as part of the DWR RAMS program at station B3670500. The headwaters start on the west side of Hwy 55 across from Green Hope High School and flow northwest through a densely populated section of Cary before entering Chatham County and draining into Northeast Creek near Old Chartham Golf Club. The two-year (2017-2018) RAMS dataset resulted in an impairment for dissolved copper and a data inconclusive (3a) rating due to low dissolved oxygen concentrations in May (3.98 mg/L) and June (0.18 mg/L) 2017 (Table 6-42). There are no flow gages available in Panther Creek, however the corresponding daily flow in Northeast Creek was low at those sampling dates, 11 and 8.4 cfs respectively. The dissolved oxygen concentrations ranged between 0.18 and 10.41 mg/L with 12.5% of the samples below the state standard. Panther Creek was added to the 2020 impaired waters list and will remain on the list until actions are taken to reduce the copper impairment and samples show it is no longer impaired. For more information on copper impairments see Northeast Creek and Third Fork Creek, please see the discussion above.

Nutrients in Panther Creek were very similar to the other urban watershed concentrations not influenced by wastewater in the New Hope Creek subwatershed (Table 6-44).

Figure 6-109: Seventeen Year (2002-2019) Flow Separated Mean Concentration for Nitrate+Nitrite, Total Kjeldahl Nitrogen, Ammonia and Total Phosphorus at Station B3660000 in Northeast Creek.



See section 6.3 for data analysis description. High flows  $\geq 75^{\text{th}}$  percentile; Medium flows between  $26^{\text{th}}$  and  $74^{\text{th}}$  percentile; Low flows  $\leq 25^{\text{th}}$  percentile at USGS Gage Station 0209741955. Flow estimate based on 1991-2020 data. (NOx: L=5.38/3.4, M=2.73/1.9, H=0.89/0.59) (TKN: L=0.92/0.92, M=0.98/0.92, H=0.85/0.83) (NH3: L=0.1/0.04, M=0.12/0.04, H=0.05/0.04) (TP: L=0.40/0.32, M=0.34/0.2, H=0.20/0.17)

#### 6.6.6.5 Crooked Creek

Crooked Creek [AU# 16-41-1-16-(1) & 16-41-1-16-(1)] from the source to the New Hope Creek arm of Jordan Lake is listed as no data on the 2022 IR. Crooked Creek (also known as Southwest Creek) drains the portion of the City of Durham between Third Fork Creek and Northeast Creek. The City of Durham supports a new Upper Cape Fear River Basin Association station at Scott King Rd.

The City of Durham's Watershed Restoration group completed a [Northeast and Crooked Creek Watershed Improvement Plan](#) in 2013. The watershed assessment and improvement plan provided a review of their water quality monitoring data, identified impacts and sources to watershed functions, and developed a comprehensive summary of potential projects throughout the watershed.

#### 6.6.6.6 White Oak Creek, Beaver Creek, Little Beaver Creek, and Parkers Creek

White Oak Creek [AU# 16-41-6-(0.7)] and the White Oak Creek arm of Jordan Lake, Beaver Creek [AU# 16-41-10-(0.5)] and the Beaver Creek arm of Jordan Lake, and Parker Creek [AU# 1641-8-(1)] and the Parker Creek arm of Jordan Lake have no available data to make a use support determination for the 2022 IR (*Figure 6-110, Figure 6-111 and Table 6-42*). These are large drainage areas that are likely impacting the water quality of the Lower New Hope Section of Jordan Lake.

The Town of Cary's Jordan Lake water supply intake is located in the White Oak Creek arm of Jordan Lake. There are several old biological samples which indicated that the conditions in White Oak Creek were fair or poor in the late 1990s and early 2000s. This subwatershed lies in the geological Triassic basin, which has highly erodible soils which lead to sedimentation that impairs water quality and aquatic habitat. Triassic soils are also poorly drained with low permeability, reducing infiltration which reduces the performance of stormwater control measures that rely on infiltration (City of Durham, 2013).

There is no expectation that the water quality in these arms of the reservoir or the creeks draining to them are any different from those described above. When resources allow, it is recommended that some type of water quality analysis be performed for verification purposes and that the communities that drain to these areas implement appropriate BMPs and the Jordan Lake Nutrient Management rules.

#### 6.6.6.7 Bush Creek

Bush Creek [AU# 16-41-4-(0.3) and 16-41-4-(0.7)] from the source to the lower New Hope River arm of Jordan Lake has no available data to make a use support determination for the 2022 IR. Fearington Village WWTP (NC0043559) is a 270,000 GPD minor wastewater treatment plant with an approved expansion flow to 0.5 MGD which discharges to a UT to Bush Creek, a zero 7Q10 stream with an average flow of 0.66 cfs. Fearington Village is the only discharger to the Lower New Hope arm of Jordan Lake. As of 2022, they have exceeded their TN load limit of 8,138 lbs/yr for the last three years (2020-2022) (*Table 6-51*). Their expansion includes a plant upgrade to include BRN which should reduce their TN loading and bring the plant into compliance with their Jordan Lake TN allocation. The plant upgrade is anticipated to be completed in the first quarter of 2024 (September 2023 NPDES NC0043559 permit factsheet).

Their current permit only requires weekly upstream and downstream monitoring for DO and temperature. It is recommended that the NPDES Permitting Branch include additional instream monitoring to incorporate nutrients, fecal coliform bacteria and the full set of physical parameters, possibly on the

mainstem of Bush Creek at Big Woods Rd [~2 miles downstream of the discharger and ~ 0.5 miles upstream of the lower New Hope arm of Jordan Lake (16-41-(3.5)a1]. This will help DWR understand the potential impact of Bush Creek on a currently unmonitored segment of the lower New Hope arm of Jordan Lake. DWR needs to work with the WWTP to bring them into compliance with their Jordan Lake TN allocation.

For more information, see the larger point source discussion in the Jordan Lake section below and the Jordan Lake point source loading chart in the Chapter 6 Appendix.

*Table 6-51: Fearrington Village WWTP Annual Total Nitrogen and Total Phosphorus Jordan Lake Allocation and their Yearly Load between 2019 and 2022. (Dark Orange Highlighted Cells Exceed their Permitted Allocation).*

<b>Fearrington Village WWTP NC0043559</b>	<b>Allocation lbs/yr</b>	<b>2019 lbs/yr</b>	<b>2020 lbs/yr</b>	<b>2021 lbs/yr</b>	<b>2022 lbs/yr</b>
<b>Total Nitrogen</b>	<b>8,138</b>	6,959	13,117	14,265	12,190
<b>Total Phosphorus</b>	<b>566</b>	592	1,566	521	281

Jordan Lake nutrient strategy (15A NCAC 02B .0270)

#### 6.6.6.8 New Hope River Arm of B. Everett Jordan Lake

B. Everett Jordan Reservoir (Jordan Lake) is a multi-use impoundment built in 1983 and operated by the US Army Corps of Engineers. The reservoir was created by damming the Haw River above the confluence with the Deep River and provides for flood control, water supply, downstream water quality protection (low flow augmentation), fish and wildlife conservation and recreation. The lake covers an area of 13,940 acres at the normal elevation of 216 feet mean sea level (MSL). The Jordan Lake watershed encompasses 1,686 square miles and consists of two distinct arms and three distinct management areas, the Haw River Arm and the Upper and Lower New Hope Creek Arms (*Figure 6-85* and *Figure 6-110*).



The Jordan Lake Assessment Units (AU #s) currently monitored for use support purposed by the Ambient Lakes Monitoring Program (ALMP) include (*Table 6-42*):

- Upper New Hope Arm [AU# 16-41-1-(14), 16-41-2-(9.5), and 16-41-(0.5)]
- Lower New Hope Arm [AU# 16-41-(3.5)a1, 16-41-(3.5)a2, 16-41-(3.5)a3]
- Haw River Arm [AU# 16-(37.3), 16-(37.5)a, 16-(37.5)b] (details reported in Robeson Creek HUC 0303000207, section 6.6.7 below)

All three management arms of Jordan Lake are impaired (2022 IR) due to chlorophyll *a* standard violations (*Figure 6-111* and *Figure 6-112*). Parts of the Upper New Hope Creek Arm and Haw River Arm are also impaired due to turbidity and high pH standard violations (*Figure 6-111* and *Table 6-42*). The Jordan Lake 2022 IR (2016-2020) data continues to show consistent elevated chlorophyll *a* concentrations throughout the lake and several sections exhibit elevated turbidity and high pH levels as a result of high biological productivity (*Table 6-53*). The chlorophyll *a* levels exceeded the standard of 40 µg/L at all six stations employed for use support between 17.5% and 79% of the time from 2016- 2020 (*Table 6-52* and *Figure 6-85*). The nutrients draining to and recycling in Jordan Lake contribute to the elevated productivity of this system.



Jordan Lake has been consistently classified as eutrophic or hypereutrophic as result of excess nutrient inputs and resulting algal production. Due to water quality concerns, the North Carolina Environmental Management Commission (EMC) declared the lake as Nutrient Sensitive Waters (NSW) in 1983, the same year it was impounded. As a result of the Clean Water Responsibility Act of 1997 [NC General Statute 143-215.1(c1) to (c5)] a nutrient response model was completed and accepted by the Water Quality Committee of the EMC in July 2002. The nutrient response model predicted a high frequency of violations of the chlorophyll *a* standard in the Upper New Hope arm segment of the lake. As a result of this model prediction, the Upper New Hope arm of Jordan Lake was placed on the 2002 NC 303(d) List of impaired waters. The Lower New Hope arm and the Haw River arm were later placed on the impaired waters list in 2006 for chlorophyll *a* impairment.

*Figure 6-110: Jordan Lake Management Areas.*

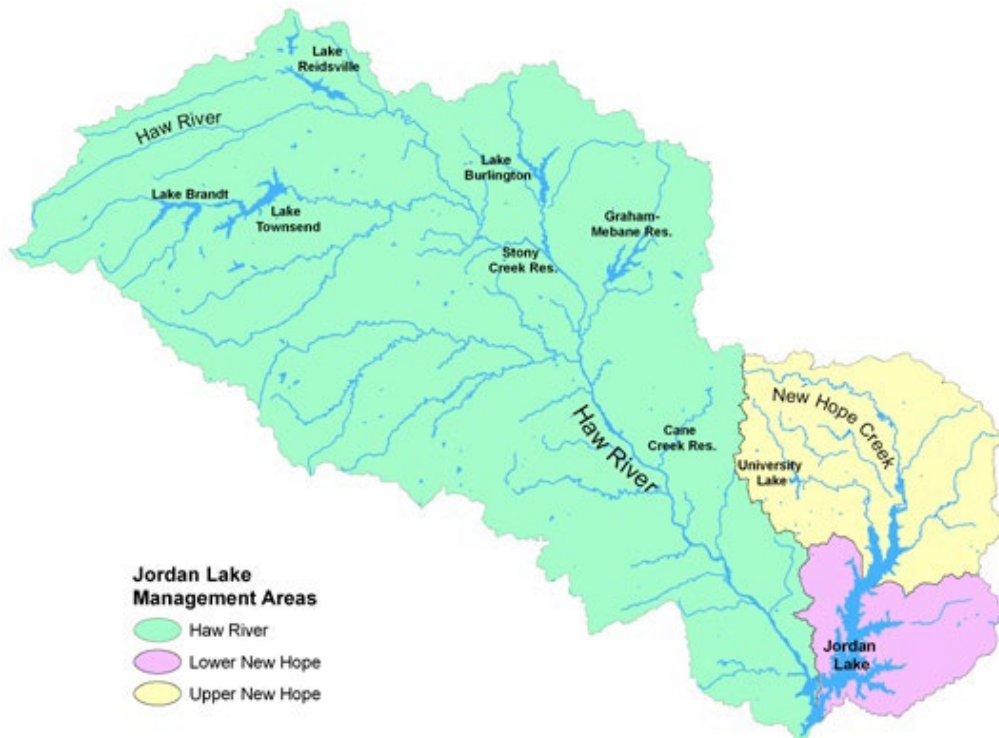


Figure 6-111: 2022 Integrated Report for Jordan Lake

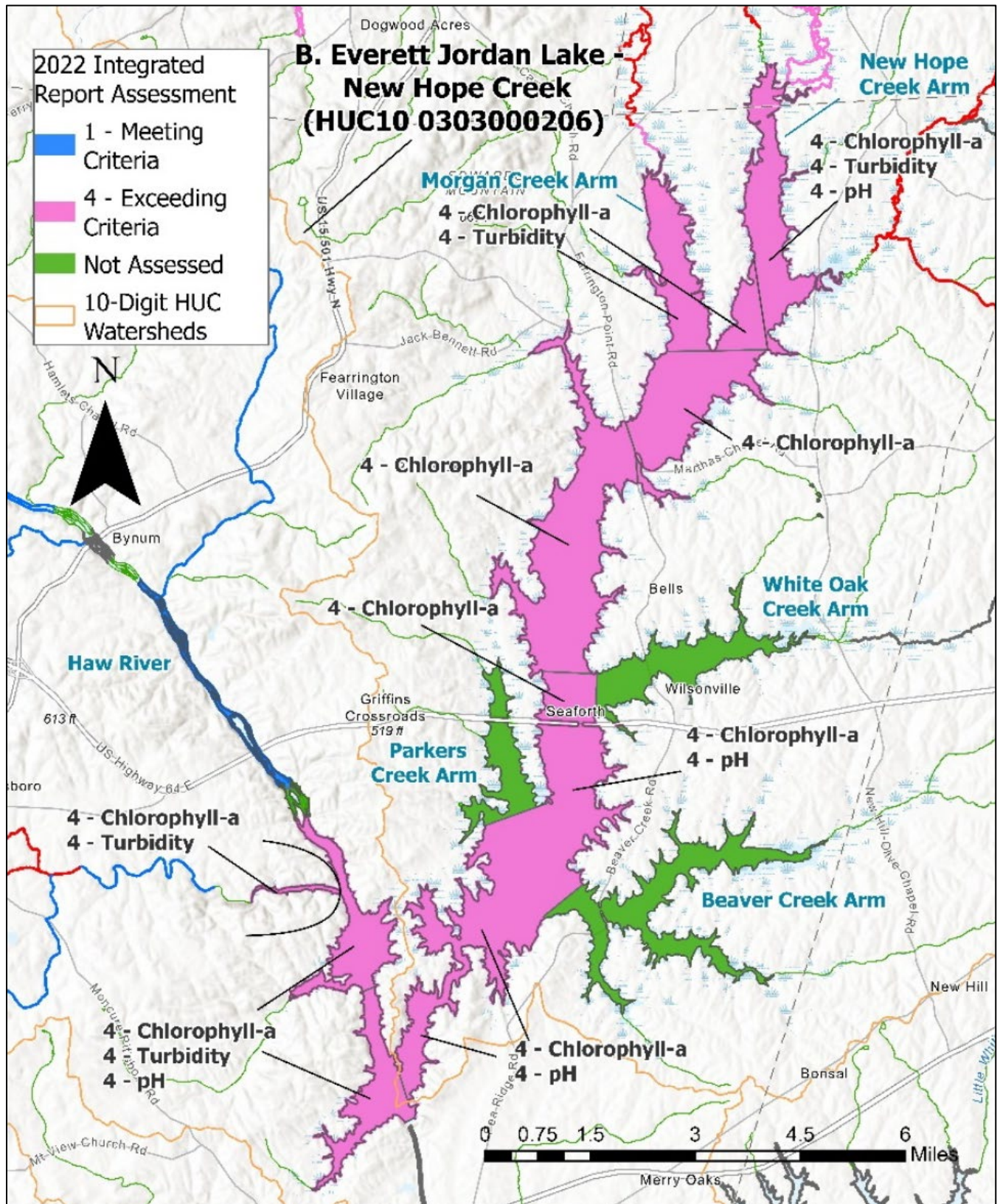


Figure 6-112: Jordan Lake Aerial photography and 2022 Integrated Report

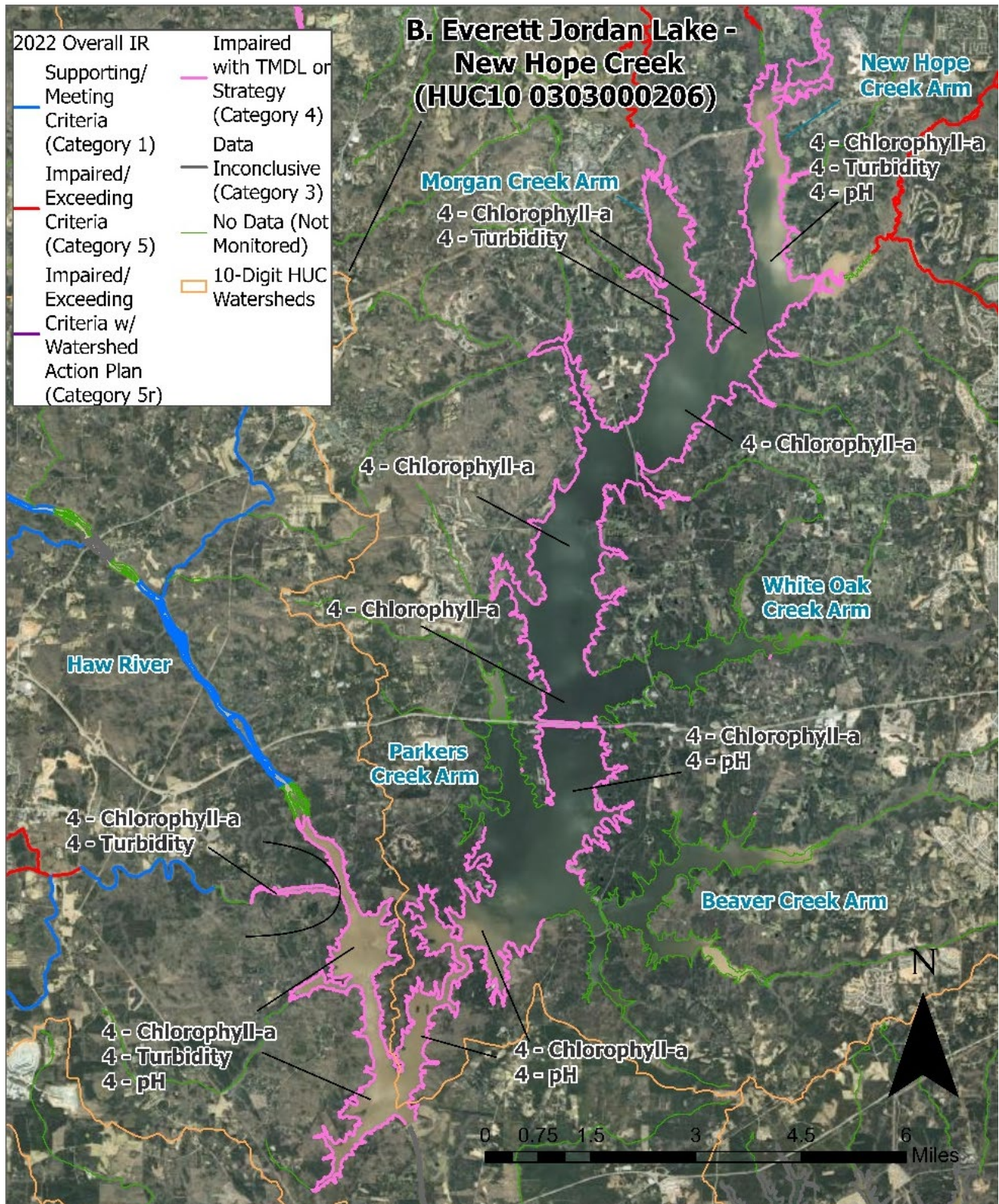


Table 6-52: 2022 Integrated Report (IR) Data Summary Results for Upper New Hope, Lower New Hope and Haw River Arms of Jordan Lake. (Data includes the number (n) of samples greater than the water quality standard, percent exceedance rate, and percent confidence rate.)

Lake Station #	Lake Arm	AU#	Chlorophyll a			pH >9			Turbidity		
			n > 40 µg/L	% >	% Conf.	n > 9 su	% >	% Conf.	n > 25 NTU	% >	% Conf.
CPF086C	Upper New Hope	16-41-2-(9.5)	43 of 57	75.4	100	5 of 56	8.9	32.8	2 of 35	5.7	12.2
CPF081A1C	Upper New Hope	16-41-1-(14)	46 of 58	79.3	100	8 of 59	13.6	76.5	4 of 40	10	42.2
CPF086F	Upper New Hope	16-41-(0.5)	39 of 57	68.4	100	3 of 60	5.0	5.3	0 of 29	0	0
CPF087B3	Lower New Hope	16-41-(3.5)a1	22 of 57	38.6	100	4 of 57	7.0	16.5	0 of 6	0	0
CPF087D	Lower New Hope	16-41-(3.5)a2	12 of 57	21.1	99	3 of 58	5.2	6.2	0 of 3	0	0
CPF0880A	Lower New Hope	16-41-(3.5)a3	11 of 58	19.0	97.3	6 of 59	10.2	45.3	0 of 6	0	0
CPF055C	Haw River	16-(37.5)a1	18 of 57	31.6	100	11 of 60	18.3	96.6	11 of 19	57.9	100
CPF055D	Haw River	16-(37.5)a2	10 of 57	17.5	94.5	8 of 59	13.6	76.5	8 of 18	44.4	100
CPF055E	Haw River	16-(37.5)a2	11 of 57	19.3	97.6	9 of 59	15.3	86.8	3 of 13	23.1	86.6

6.6.6.9 B. Everett Jordan Lake – New Hope Creek Watershed Summary

Best management practices to address nutrients (nitrogen and phosphorus), fecal coliform bacteria, turbidity/sedimentation and volume control are necessary to improve water quality throughout the Jordan Lake – New Hope Creek watershed.

6.6.6.9.1 Jordan Lake TMDL

A TMDL for Jordan Lake was approved by the USEPA in September 2007. The objective of a TMDL is to estimate the allowable pollutant loads and allocate the loads to known sources so that the waterbody may be restored to its intended uses. Through the combined efforts of many watershed stakeholders and DWQ, multiple modeling tools were developed to evaluate conditions in the reservoir and potential management strategies. This included the development of a calibrated hydrodynamic and nutrient response model for the years 1997-2001 (baseline period), an effluent nutrient delivery model, a nutrient fate and transport model and a watershed loading model. A nutrient management strategy was developed based on reductions in both total nitrogen and total phosphorus. Both point and nonpoint sources bear an equal burden for nutrient reductions. The current (2023) required nutrient load reductions for each Jordan Lake management area (Figure 6-110) is 35% TN, 5% TP in the Upper New Hope Arm and 8% TN, 5% TP in the Haw River Arm and no increase in TN or TP load in the Lower New Hope Arm.

Jordan Lake Management Area	Total Nitrogen Load Reduction*	Total Phosphorus Load Reduction*
Upper New Hope Arm	35%	5%
Lower New Hope Arm	0% - No Increase in Load	0% - No Increase in Load
Haw River Arm	8%	5%

\*Nutrient load reduction loads could change in the future based on newer information and rules readoption. For the most up to date information see DEQ-DWR Nonpoint Source Planning [Jordan Lake Nutrient Strategy](#) webpage. Jordan Lake nutrient strategy (15A NCAC 02B .0262)

More information regarding the TMDL and the baseline nutrient loads for Jordan Lake can be found in the [approved TMDL document \(Jordan Lake TMDL\)](#). It is also important to note that the TMDL is based on an annual load allocation necessary to achieve the chlorophyll *a* target (state chlorophyll *a* standard of 40 µg/L or less, will be met 90 percent of the time) during the critical condition period of May through September (summer months).

Through SL 2018-5, the NC Legislature mandated updated water quality modeling of Jordan Lake and its watershed. Results of the updated Jordan Lake model will shed light on the adequacy of the 2007 TMDL described here. See the *NC Policy Collaboratory Jordan Lake Study* section below for further information.

#### 6.6.6.9.2 Jordan Lake Watershed Nutrient Management Strategy

Development of the Jordan nutrient strategy was a multi-year effort with extensive stakeholder involvement dating back to lake modeling which began in the late 1990s. In 2008, the EMC adopted a set of rules that were revised somewhat by the 2009 session of the General Assembly. The Jordan Lake nutrient rules (Title 15A NCAC 02B .0263-.0273) went into effect August 2009 with the passage of Session Laws 2009-216 and 2009-484.

From 2011 to 2018, while some Jordan rules were being implemented (including buffer protection), a series of session laws delayed other rules or portions of rules and ultimately halted most stormwater implementation. They also required nutrient management research and modeling by the NC Policy Collaboratory, which was completed in December 2019.

The result is that most Jordan rules were somewhat delayed but are now implemented as originally adopted, while implementation of new and existing development stormwater rules is barred in favor of the rules readoption process. Jordan Lake Nutrient Strategy rules readoption began in 2020 with a large stakeholder engagement process initiated in 2023. For more detailed information on the Jordan Lake rules readoption see Section [6.6.6.9.4](#) below.

#### Jordan Lake Nutrient Strategy Rules currently (2023) in effect:

- Agriculture (.0264): Achieve and maintain the percentage reduction goals for the collective loss of nitrogen and phosphorus from agricultural lands from their respective 1997-2001 baseline levels. Compliance tracked by NC Division of Soil and Water Conservation, overseen by an agriculture committee and reported to DWR.
  - Status: Beginning with 2014 annual report, collective compliance was documented as achieved for all 3 subwatersheds.

- Existing Development Stormwater (.0266): **Stage 1:** Reduce the nutrient impact from existing development throughout the Jordan Lake watershed through local government programmatic measures: public education, mapping of stormwater systems, illicit discharge detection and removal, identification of retrofit opportunities and upkeep of existing stormwater practices. Annual reporting to DWR.
  - Status: Annual reporting continues until rule readopted.
- Riparian Buffer Protection (.0267): Protect and preserve existing vegetated 50-foot riparian buffers on perennial and intermittent streams and reservoirs to maintain their nutrient removal and stream protection functions. Mostly implemented by local governments, the rest by DWR.
  - Status: Local buffer protection programs in place since 2011.
- Wastewater Dischargers (.0270): Annual nitrogen and phosphorus loading limits for point source wastewater discharges that achieve strategy loading reduction goals for these discharge flows. Implemented by DWR NPDES Permitting program.
  - Status: Dischargers complied with calendar 2010 annual phosphorus limits requirement and have remained in compliance. Nitrogen limits compliance delayed from original 2016 date to 2019 or 2021 (Greensboro); all dischargers in compliance since then.
- State and Federal Entities Stormwater (.0271)- **New Development:** Post-construction runoff nutrient controls required for state and federal development projects; implemented by Division of Energy, Mineral, and Land Resources Stormwater program.
- Fertilizer Management (.0272): Requires commercial fertilizer applicators working in Jordan watershed to either take fertilizer management training provided by NC Cooperative Extension Service or apply fertilizer in the watershed pursuant to an approved nutrient management plan.
  - Status: Extension training series completed; slide sets remain available on DWR website for applicators to obtain approval as needed.
- Offsetting Nutrient Loads (.0273): Where other Jordan rules provide parties with offset options for meeting rule requirements, this rule establishes procedural standards for obtaining such nutrient reduction credits.

Jordan Lake Nutrient Strategy Rules with implementation halted by SL 2016-94, deferred to rules readoption:

- New Development Stormwater (.0265): Meet strategy nitrogen and phosphorus percent reduction goals on a project basis by requiring development in local government jurisdiction to achieve and maintain nitrogen and phosphorus loading rate targets as well as prevent erosive flow through the buffers.
- Existing Development Stormwater (.0266): **Stage 2:** Reduce the total nitrogen and total phosphorus load from existing development in local government jurisdiction by 8% and 5%, respectively, in all lake arms relative to the 1997-2001 baseline period if water quality standards are not met. Reduce the total nitrogen load from existing development by 35% in the Upper New Hope Arm relative to the 1997-2001 baseline period if water quality standards are not met in that arm by March 2023 via 8% and 5% loading reductions.
- State/Federal Entities Stormwater (.0271)- **Existing Development Section:** Achieve and maintain percent reduction goals for nitrogen and phosphorus on state and federal owned new and existing non-road developed lands and existing roads.

#### 6.6.6.9.3 NC Policy Collaboratory Jordan Lake Study

Session Law 2016-94 and 2018-5 created the NC Policy Collaboratory and directed it to study and model nutrient dynamics in Jordan Lake and its watershed. The final report can be found online at the [NC Policy Collaboratory website](#). Jordan Lake nutrient strategy rules re-adoption was able to proceed after DEQ received the final report in December 2019. In 2020, DWR contracted additional lake model refinements to better inform rulemaking with the goals of incorporating final Collaboratory study data. These included improved surface elevation predictions, inflows estimating from ungagged portions of the watershed, loading estimates of dissolved inorganic phosphorus, more extensive chlorophyll *a* observed data as well as improved calibrations and development of standards attainment curves. The three-dimensional mass balance-based water quality model of Jordan Lake was reviewed by DWR and made available to the public for review and comment. The [Jordan Lake Water Quality Model Development Final Report](#) was submitted to DWR on March 15, 2024 (Bowen, 2024). For the most up-to-date information on the Jordan Lake model development, see the DEQ-DWR Nonpoint Source Planning [Jordan Lake Nutrient Strategy](#) webpage.

#### Key takeaways of the Jordan Lake Collaboratory Study:

- Lake recovery is a long-haul, multi-decadal endeavor.
- Rule delays increased the scale of nutrient reduction needs.
- Distributed control of runoff throughout the watershed is needed in addition to point source reductions. It is deemed essential by the Clean Water Act and is reflected in the current Jordan Lake watershed nutrient strategy.

#### NC Policy Collaboratory Recommendations for Nutrient Management in the Jordan Lake Watershed include:

- Reduce point source loads
- Prioritize older urban infrastructure retrofits
- Mitigate agricultural loading, especially during wet years
- Minimize or offset new development loading
- Maintain and repair septic systems
- Fence livestock out of streams
- Increase riparian buffers and infiltration
- Coordinate forest preservation
- Restore streams and reconnect floodplains
- Strengthen local government collaboration
- Increase revenue generation opportunities for water quality

#### **Jordan Lake Study Findings**

- Significant recovery delays are projected due to sediment contributions.
- High-flow events deliver a significant proportion of nutrient load, and contribute to lake sediment resuspension, especially in the shallow upper arms. Management measures need to adapt to this phenomenon.
- The Jordan Lake nutrient response model mandated by SL 2018-5 was built using lake monitoring data collected between 2014 and 2018. It found that reductions in stream inputs to the lake of up

to 50% of both nitrogen and phosphorus would be insufficient to decrease chlorophyll *a* exceedances to meet the 40 µg/l standard. An average of all stations estimated that 50% reductions in both nutrients would result in 32% exceedance of the chlorophyll *a* standard initially, with greater reductions in chlorophyll production over time as lake sediments deplete. DWR subsequently contracted further refinements to the model to better inform regulatory issues. The [Jordan Lake Water Quality Model Development Final Report](#) was submitted to DWR on March 15, 2024 (Bowen, 2024). For the most up-to-date information on the Jordan Lake model development, see the DEQ-DWR Nonpoint Source Planning [Jordan Lake Nutrient Strategy](#) webpage.

### **Watershed Study Findings**

- All nutrient sources regulated under current rules still contribute significantly, with point sources remaining a dominant contributor. Point sources are the largest total nitrogen contributor (50%) and 2nd largest total phosphorous contributor (25%).
- Large storms or high flow events carry a significant fraction of annual nutrient loads as well as present additional challenges (for example, localized flooding).
- Both septic and sanitary sewer collection systems contribute to nutrient loading.
- Older urban development (pre-1980) contributes more than twice the loading of post-1980 development.
- Most of the nutrient load from upstream portions of the watershed reaches Jordan Lake.
- Identified needs:
  - Increase infiltration and reduce runoff
  - Reconnect streams to floodplains
  - Improve buffers

### **BMP Cost Effectiveness Study Findings**

Wastewater treatment plant improvements, riparian buffers, and illicit discharge detection and elimination (IDDE) are the lowest-cost strategies per pound nutrients removed.

### **Agricultural Study Findings**

- Watershed agricultural acreage has remained stable while development has occurred largely on forested lands.
- Pasture and hay lands comprise about 60% of watershed agricultural acreage. These cover types are generally under-fertilized.
- Forty percent of agriculture-adjacent stream miles are not buffered.
- The greatest nutrient loading is from grazed pasture with stream access and can be improved with livestock exclusion fencing and buffers.
- Where organic nutrient sources are used, particularly biosolids, phosphorus is typically overapplied. This presents an opportunity for phosphorus loading reductions where soil test P is high or very high.
- In wet years, nutrient loading from agricultural land increases more than loading from other land covers.

### Forest Preservation Study Findings

A policy analysis was conducted on the merits or shortcomings of forest conservation as a nutrient control strategy. It was determined that forest preservation needs a coordinated watershed-wide effort across local jurisdictions to hedge against future nutrient load increases from development. Without planned and coordinated efforts, development is likely to simply shift from protected forest tracts to nearby lands, especially in large watersheds with more available open land. Forest preservation has many co-benefits in environmental, social and economic categories, including health benefits. Incentives need to be developed to conserve high-priority land, reforest agricultural land and coordinate planning and development across local jurisdictions. Most development in the watershed appears to have occurred on forested land, which has the lowest nutrient loading rates of any land use, so in general, a tool for reducing nutrient loading increases from development, aside from controlling it directly, would be to shift development more to non-forested lands.

#### 6.6.6.9.4 Jordan Water Supply Nutrient Strategy Rules Readoption

*The DWR is implementing a collaborative public involvement process to rethink and revise the nutrient management strategy for the Jordan Lake watershed.*

Rules readoption timeline (*updated as of October 2025*):

	Readoption Timeline*	Readoption Steps
Lake Model Finalization	Winter 2023 - Fall 2024	Lake model completion, external review, finalization
Stakeholder Engagement	Nov 2023, Feb 2024, July 2024	All interested parties stakeholder meetings
	Feb – June 2024	Technical focus groups - Round 1 (meeting per rule type)
	Sept - Dec 2024	Technical focus groups - Round 2 (meeting per rule type)
	Jan – May 2025	Technical focus groups - Round 3 (meeting per rule type)
Draft Rules	June-August 2025	Draft rules
Formal Rulemaking	August - Jan 2025	Fiscal analysis; OSBM approval
	May and July 2026	Request Environmental Management Commission approval to proceed with comment and hearings
	Summer 2026 – Spring 2027	Public hearings and comment, Hearing Officers deliberations, EMC Rules adoption
	Spring 2027	Request RRC rules approval

\*For the most up to date information on the rules readoption information and timeline, see DEQ-DWR Nonpoint Source Planning [Jordan Lake Nutrient Strategy](#) webpage.

DWR is also an advisory and planning member of [Jordan Lake One Water](#) (JLOW) – a Central Pines Regional Council (formally TJCOG) administered watershed-wide collaborative committed to developing a

stakeholder-driven integrated watershed management plan, using a triple bottom line approach, encompassing environmental, social, and economic benefits. JLOW and DWR hope to collaborate to further the reach and benefits of both public involvement processes. The desired result from DWR's perspective is to achieve an implementable, effective and well-supported nutrient strategy for the Jordan Lake watershed.

DWR-NPS Jordan website link: <https://www.deq.nc.gov/about/divisions/water-resources/water-planning/nonpoint-source-planning/jordan-lake-nutrient-strategy#OverviewBackgroundMaps-9704>

#### 6.6.6.9.5 Jordan Lake One Water (JLOW) and the One Water Approach

“What is One Water? One Water is a transformative approach to how we view, value, and manage water. The One Water approach views all water - from the water resources in our ecosystem to our drinking water, wastewater and stormwater – as resources that must be managed holistically and sustainably in order to secure a bright, prosperous future for our children, our communities and our country” ([JLOW website](#)).



JLOW was initiated in 2017 due to stakeholder interest in improving watershed management beyond the Jordan Rules nutrient requirements. Participants met quarterly, formed an advisory committee and developed a workplan. In October 2019, JLOW held a meeting to kick off its workgroup planning. For the next 18 months, more than 75 stakeholders from across the watershed participated in workgroups pertaining to environmental, social and economic benefits; integrated watershed management; financial and governance structure; and evaluation, monitoring and reporting methods. In the summer of 2021, the JLOW advisory committee released an action plan: “[A One Water Vision for the Jordan Lake Watershed](#)”.

The plan has two overarching recommendations:

1. Form a transitional JLOW organization
2. Co-develop a framework for collaboration between JLOW and NC DEQ to address regulatory concerns, including nutrient requirements

In addition, the plan contains the JLOW value proposition:

- The Jordan Lake One Water stakeholders seek to shape water policy in the Jordan Lake Watershed to be integrated—to consider all water as valuable. The Jordan Lake One Water approach will offer a more flexible framework and a broader range of management options than the traditional regulatory model. It offers a path to finding solutions with a triple-bottom-line business case, helping to assure that money spent in the watershed will achieve more per dollar than the traditional regulatory model and play a role in creating a community that can better withstand disruptions. Better outcomes, more choice and cost neutrality means a more resilient region and more public support and satisfaction at all levels.

DWR has been involved in and supportive of the JLOW planning process since its inception. As widespread stakeholder interest in the JLOW process materialized, DWR agreed to fund the initial JLOW planning endeavor through the end of 2021. While DWR is responsible for Jordan Lake Watershed nutrient rules re-adoption, the division will seek to design rules that enable JLOW's One Water intentions to the greatest

extent possible. DWR also plans to build on the stakeholder involvement initiated by JLOW as it reengages interested parties toward rules readoption. JLOW and DWR hope to collaborate to further the reach and benefits of both public involvement processes. The desired result from DWR's perspective is to achieve an implementable, effective, and well-supported nutrient strategy for the Jordan Lake Watershed.

#### 6.6.6.9.6 Haw River/Jordan Lake Watershed Point Source Compliance

To address water quality problems in NSW waters, the N.C. General Assembly passed the Clean Water Responsibility Act of 1997 [NC General Statute 143-215.1(c1) to (c5)]. This set technology-based total nitrogen (TN) and total phosphorus (TP) limits for facilities discharging greater than 0.5 MGD into NSW waters.

The Jordan Lake TMDL specified TP and TN load reductions relative to the 1997-2001 baseline loads for each of the three arms of the lake. The required nutrient load reductions for each Jordan Lake management area (*Figure 6-110*) are, as of 2022:

Jordan Lake Management Area	Total Nitrogen Load Reduction*	Total Phosphorus Load Reduction*
Upper New Hope Arm	35%	5%
Lower New Hope Arm	0% - No Increase in Load	0% - No Increase in Load
Haw River Arm	8%	5%

\*For the most up to date information see DEQ-DWR Nonpoint Source Planning [Jordan Lake Nutrient Strategy](#) webpage. Jordan Lake nutrient strategy (15A NCAC 02B .0262)

The allowable point source loads (waste load allocations) for TN and TP were distributed among the affected dischargers in proportion to their maximum permitted flows, and dischargers with permitted flows of 0.1 MGD or greater received TP and TN limits equivalent to those allocations. In 2009, DWR added effluent limitations, monitoring requirements and special conditions for TP to individual NPDES permits. All allocations/limits are annual mass limits and apply on a calendar-year basis.

The Jordan Lake wastewater rule (15A NCAC 02B .0270) provided the option for dischargers to form a group compliance association and work together to meet their combined nutrient limits. Under this option, individual dischargers are subject to aggregate nutrient limits in a group NPDES permit in lieu of the nutrient limits in their individual NPDES permit.

In 2016, the municipalities of Greensboro, Mebane, Reidsville, and Graham established the Haw River Nutrient Compliance Association (HRNCA) and work collectively to meet the point source nutrient targets in the Haw River subwatershed. The City of Burlington joined the association in 2019.

The HRNCA group permit (NCC000003) governs the collective discharge of total phosphorus and total nitrogen (TN only starting in 2023) from the co-permittees to the Haw River arm of Jordan Lake. The individual members' permits will remain in effect and will continue to govern the other parameters of concern. As long as HRNCA does not exceed the association cap in a given calendar year, the members are deemed to be in compliance with their individual limits. If the association exceeds the group cap, the

individual limits listed in the group permit will become effective and those members that contributed to the exceedance are subject to enforcement for their individual exceedances. In this case, the association and its members are also required to purchase nutrient offset credits (from Division of Mitigation Services) to mitigate the impact of the excess nutrient load to Jordan Lake (DWR, 2022).

The HRNCA NPDES permit NCC000003 was renewed and became effective October 1, 2022, and expires on December 31, 2026. The total TN discharge allocation is 1,494,642 lbs/yr with a lake delivered TN load allocation of 851,991 lbs/yr (HRNCA 2022 permit). The total association’s TP discharge allocation is 187,888 lbs/yr with a lake delivered TP load allocation of 100,063 lbs/yr (HRNCA 2022 permit).

According to the HRNCA 2022 year-end report to DWR, the group discharged only 42.1% of the TP and 60.2% of the TN Jordan Lake allocation. The group compliance TN limit does not become effective until 2023. All individual TN limits were in effect through 2022 for all of the HRNCA members. See Chapter 6 Appendix for individual NPDES permit TN and TP loads for 2009-2022.

The 2022 TN and TP point source load by Jordan Lake management areas were met, with the exception of the lower New Hope arm, which added 4,052 lbs of TN above the goal of 8,138 lbs/yr. The only discharger to the lower New Hope is the Fearington Village WWTP (*Table 6-53*). Details on the Fearington Village WWTP are discussed above in section 6.6.6.7.

*Table 6-53: Jordan Lake Total Nitrogen and Total Phosphorus Point Source Yearly Load (2019-2022) by Management Area.*

Jordan Lake Management Areas	Nutrient	Area Nutrient Cap	2019 lbs/yr	2020 lbs/yr	2021 lbs/yr	2022 lbs/yr
Upper New Hope Arm	TN	434,170	348,553	335,445	336,350	349,701
	TP	32,919	20,424	17,331	16,096	22,245
Lower New Hope Arm	TN	8,138	6,959	13,117	14,265	12,190
	TP	566	592	1,566	521	281
Haw River Arm	TN	1,543,822	1,962,781	1,688,956	1,000,152	910,752
	TP	194,056	93,755	101,978	130,422	83,314
Total Lake Load	TN	1,986,130	2,318,273	2,037,518	1,350,767	1,272,643
	TP	227,541	114,771	120,875	147,039	105,840

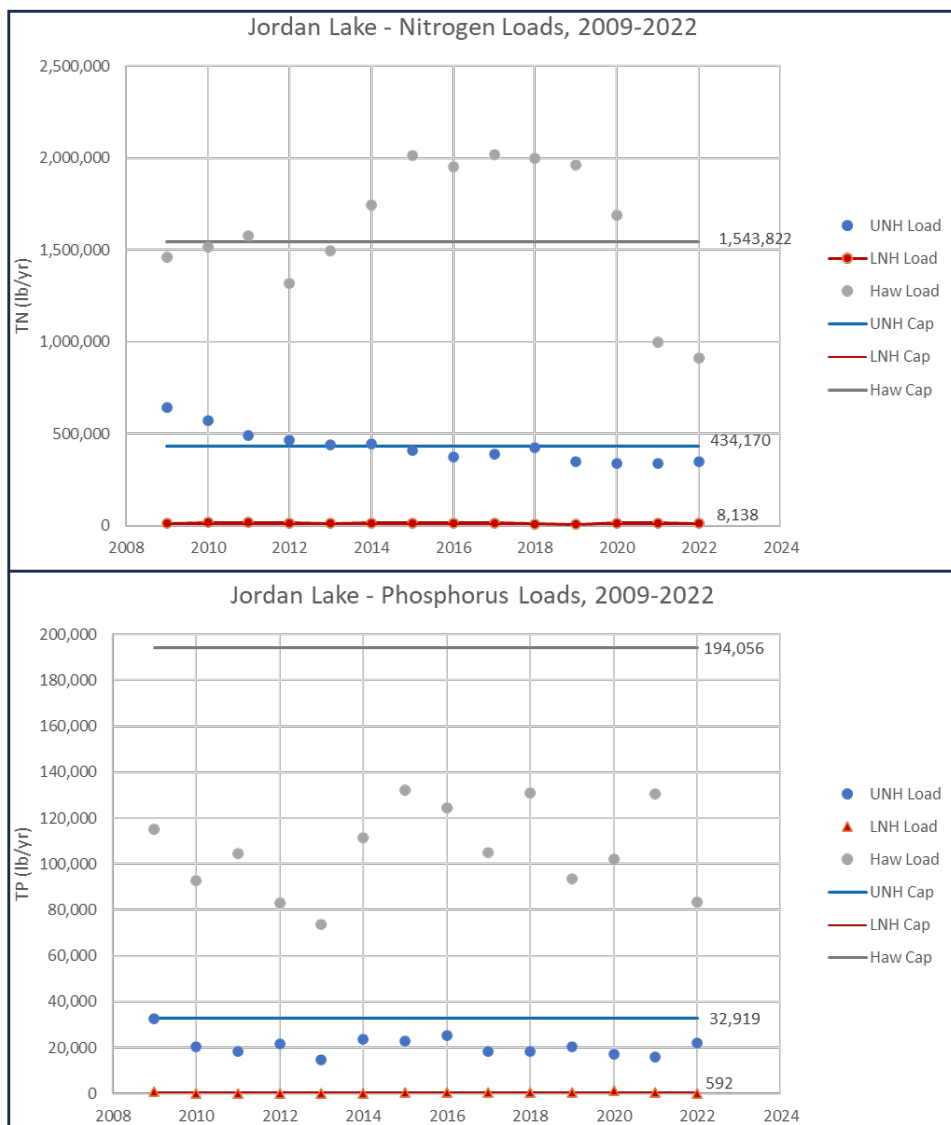
Values in **RED** denote the yearly load greater than the permitted allocation for that management area.

The majority of the point sources in the Jordan Lake subwatershed have made great progress in reducing their TN and TP loading to the lake (*Figure 6-113*). The yearly TN load in the Haw River dropped substantially in 2021 with the completion of the City of Greensboro’s T.Z. Osborne treatment plant expansion (*Figure 6-113*). T.Z. Osborne’s yearly TN load dropped from a high of 1,537,981 lbs in 2019 to 518,041 lbs in 2022, a 66% reduction. The City of Greensboro closed their North Buffalo WWTP and upgraded and expanded their 40 MDG T.Z. Osborne to a 56 MGD 5-stage BNR operation. Their NPDES permitted 891,272 lbs/yr TN limit went into effect January 1, 2021. See the subbasin chapter appendix for a table of the yearly TN and TP loads by discharger.

It is recommended that the NPDES Permitting Branch include instream monitoring for nutrients, fecal coliform bacteria and the full set of physical parameters in all NPDES wastewater permits in order to confirm compliance with instream water quality standards and for assessment and compliance with the TMDL/strategy reductions. See the permitting strategy in Chapter 3 section 3.2.4.2 for a table of parameters. Under most circumstances, members of the monitoring coalition are exempt from collecting instream data, however the requirements should be included in all permits in case membership is dropped or terminated water quality data will still be available for assessment and trend analysis.

Publicly Owned Treatment Works (POTWs) must work with DWR to determine if their Pretreatment Program is sufficiently evaluating indirect dischargers to protect against accepting waste with potential emerging contaminants.

Figure 6-113: NPDES Point Source Total Nitrogen and Total Phosphorus Yearly Total Load to the Three Jordan Lake Management Areas.



#### 6.6.6.9.7 Local Initiatives

##### *Clean Jordan Lake*

There are many efforts taking place in the Jordan Lake watershed to improve and protect the water quality in the subbasin. Clean Jordan Lake is specifically dedicated to cleaning the shorelines of Jordan Lake proper.

[Clean Jordan Lake](#) is a nonprofit organization founded in July 2009 with the mission to remove trash from the shoreline of Jordan Lake. The trash littering the shoreline and the lake originates from illegal dumping in the watershed's feeder streams and rivers and from recreational shoreline and lake users. Stormwater runoff accounts for most of the trash that is deposited along the high-water mark of many remote coves, in the Haw River arm of the lake especially. Tires, orange construction barrels, hot water heaters, propane tanks, dolls, basketballs and soccer balls in addition to the usual assortment of glass and plastic bottles may be found in abundance. Fishing access points and the public land surrounding the lake collect large amounts of litter left behind, such as dirty diapers, insect repellent cans, camping fuel canisters, plastic bait containers and fishing tackle. Negative impacts to water quality and wildlife habitat and health are a result.

Clean Jordan Lake's mission is being accomplished through:

- Annual fall and spring trash cleanups in conjunction with the U.S. Army Corps of Engineers, NC Big Sweep, Haw River Assembly and Chatham County Environmental Quality Department
- Public service cleanups by various volunteer groups throughout the year
- Adopt-A-Shoreline Programs for habitually littered shoreline sections
- Social media projects to raise public awareness and to inform local and state government agencies

As of May 2023, with the help of more than 10,000 volunteers, the organization has removed 208 tons of trash, including about 21,000 bags of trash and 5,000 tires. For more information, please see their [website](#).

##### *Durham County Soil and Water Conservation District*

The Durham County Soil and Water Conservation District's mission is to conserve, enhance and promote the natural resources of Durham County by providing technical assistance, environmental education and economic incentives to Durham County citizens. The Community Conservation Assistance Program (CCAP) is a program used in urban areas of the county to address stormwater runoff impacts. The City of Durham has an interlocal agreement with the Durham County Soil and Water Conservation District to help support CCAP projects in the city. From 2019-2022, six projects were installed, one in Mud Creek watershed and five in Third Fork Creek watershed. They included three downspout disconnections, one rain garden and two cisterns to help capture stormwater runoff from urban sources. The City of Durham renewed their agreement in 2023. For information and eligibility for CCAP projects in your area, see your county Soil and Waters Conservation agents. In Durham County see the following [CCAP link](#).

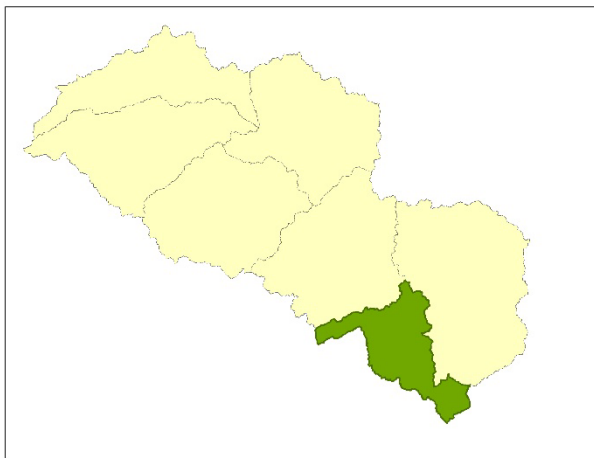
##### *Watershed Action/Implementation Plans*

There are several EPA approved nine-element watershed action plans written for streams in the Jordan Lake – New Hope Creek watershed ([Table 6-13](#)). *DWR recommends the implementation of the Watershed Action Plans (WATs) and encourages the development of additional community driven WATs to help address water quality impairments and degraded habitats.*

### 6.6.7 Robeson Creek – Haw River Watershed (0303000207)

Includes: Haw River, Robeson Creek, Dry Creek & Pokeberry Creek

Robeson Creek watershed (0303000207) is the lower portion of the old DWQ subbasin 03-06-04 and includes the Haw River below Jordan Lake dam, which was in the old DWQ subbasin 03-06-07. The Town of Pittsboro is the only municipality that falls within this watershed. The most common land use in 2019 was forest (72%), with development covering approximately 11%, and agriculture accounting for 7.5% (2019 NLCD). The Army Corps of Engineers protects much of the land surrounding Jordan Lake proper from development along the shoreline. This is a rapidly developing watershed with the 7,068-acre Chatham Park development underway. There are several other large developments that likely impact surface waters like the 1,600-acre multiuse Brier Chapel which mainly drains to the Pokeberry Creek subwatershed.



The Haw River in this watershed flows from just above the confluence with Dry Creek and becomes the Haw River arm of Jordan Lake about 0.5 miles downstream of Hwy 64. The Haw River then flows from the dam at Jordan Lake about 4.3 miles where it becomes the Cape Fear River at the confluence with the Deep River (*Figure 6-5, Figure 6-13 and Figure 6-16*).

As of 2022, there are two major and four minor NPDES wastewater discharge facilities and 23 single-family permits with a combined as-built discharge of 1.13372 MGD (1.127 MGD for major and minor facilities and 6,720 gpd for single-family). The two major NPDES dischargers are industrial facilities: Arclin USA (NC0000892, 0.1 MGD) which discharges to the Haw River and Moncure Holdings West WWTP (NC0001899, 0.244 MGD) which discharges to the Haw River and Shaddox Creek. There are also nine NPDES and two state stormwater facilities, but no AFO permits in this watershed. However, there appear to be several poultry operations located mainly in the Dry Creek subwatershed (these are deemed permitted, see Chapter 3 for more information). There are 927 permitted field acres of wastewater irrigation, reclaimed water and residual solids land application. The reclaimed water field acres are primarily associated with two permitted non-discharge facilities: the Chapel Ridge Collection System (WQ0022870, 427.7 acres) and Briar Chapel WWTP (WQ0028552, 206 acres). The residual solids land application fields are associated with City of Burlington (WQ0000520, 78.3 acres), the Orange Water and Sewer Authority (WQ0001169; 49.7 acres), Siler City (WQ0003226, 78.5 acres), Harnett County (WQ0007066, 17.8 acres) and the Town of Pittsboro RLAP (WQ0020019, 20.3 acres). The wastewater irrigation is primarily associated with the Arauco-Moncure WWTF (WQ0003396, 39.5 acres). There are also 18 small wastewater irrigation fields associated with single-family dwellings that are generally less than a third of an acre in size.

For this assessment (2002-2020), there are five ambient stream monitoring stations (two AMS, two UCFRBA coalition, one co-located), seven benthic macroinvertebrate (including both basin and special study sites) and two fish community stations used to assess the water quality conditions over this time

period. Ambient (*Table 6-54*) and biology stations discussed in this section were used in the 2022 IR. A complete list of all 2002 to 2020 stations is located in the Chapter 2 Appendix.

*Table 6-54: Haw River (0303000207) Ambient Monitoring Stations Collected by DWR and the Upper Cape Fear River Basin Association Monitoring Coalition.*

Station ID	Station Location	Monitoring Program*	County	Stream AU#	Stream Classification + NSW	HUC 12
B2100000	HAW RIV AT SR 1713 NR BYNUM	AMS/ UCFRBA	Chatham	16-(28.875)	WS-IV	30300020702
B2210000	HAW RIVER AT US 64 NR PITTSBORO	UCFRBA	Chatham	16-(36.7)	WS-IV	30300020704
B2450000	ROBESON CRK AT BOAT ACCESS OFF SR 1943 NR HANKS CHAPEL	AMS	Chatham	16-(37.5)	WS-IV; CA; B	30300020703
B4050000	HAW RIV BELOW JORDAN DAM NR MONCURE	AMS	Chatham	16-(42)	WS-IV	30300020705
B4080000	HAW RIVER AT OLD US 1 NR HAYWOOD	UCFRBA	Chatham	16-(42)	WS-IV	30300020705

Monitoring Program\*: AMS = DWR Ambient Monitoring System; UCFRBA = Upper Cape Fear River Basin Association; RAMS=DWR Random Ambient Monitoring System. Green highlighted stations no longer sampled.

The major water quality impacts in this watershed are related to elevated turbidity and nutrient impacts to the Haw River arm of Jordan Lake and Robeson Creek. There are two ambient monitoring stations above the dam, one on the Haw River near Bynum (B2100000) and the other in the Robeson Creek arm of Jordan Lake (B2450000). There are also two ambient stations on the Haw River below the Jordan Lake dam (B4050000 and B4080000). There are three additional ambient monitoring stations collected monthly by the Intensive Survey Branch (ISB) as part of the Ambient Lakes Monitoring Program (ALMP) (CPF055C, CPF055D and CPF055E). These three lake stations are collected in the same sampling run with the other six lake stations in the Upper and Lower New Hope Arm of Jordan Lake (*Figure 6-85*). Two additional ambient monitoring stations were added on Robeson Creek in 2021 as part of an agreement with the Upper Cape Fear River Basin Association and the Town of Pittsboro/Chatham Park Water Recovery Center partnership. The coalition added a station upstream of their wastewater discharge point at Hwy 15 (B2300000). The DWR AMS program added a downstream station near Whites Mobil Home Park Road (B2420000) to capture impact from the treatment plant and stormwater impacts from the proposed Chatham Park development. Data is not currently available for these new stations.

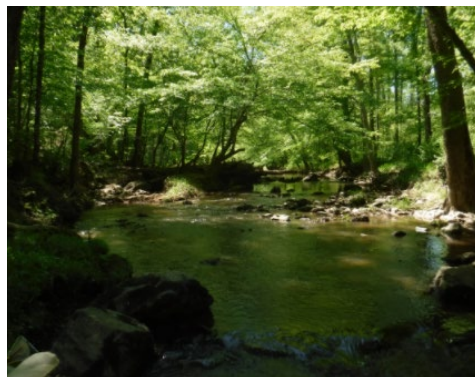
The Haw River arm of Jordan Lake is impaired due to standard violations of chlorophyll *a*, high pH and turbidity. As part of the Jordan Lake TMDL/Nutrient Management Strategy, a specific nutrient reduction goal was established in 2009 for the Haw River watershed. A total load reduction of 8% total nitrogen and 5% total phosphorus from the 1997-2001 baseline was established in order for this segment of Jordan Lake to meet the 40 µg/L chlorophyll *a* standard. See section 6.6.6.9 for more information on the Jordan Lake Strategy.

Robeson Creek, the largest subwatershed in this 10-digit HUC, flows through the Town of Pittsboro and drains into the Haw River arm of Jordan Lake. The upper portion of the stream is impaired due to degraded benthic macroinvertebrate community health, community structure, and aquatic habitat. The lower portion of the watershed is impaired due to standard violations for chlorophyll *a* and turbidity (*Table 6-55*). There is a 2004 EPA approved TMDL for a portion of Robeson Creek which requires a 71% reduction in total phosphorus load. There was also a Robeson Creek Watershed Restoration Plan developed in 2003 ([NC Watershed Restoration Plans](#)).

There is also as comprehensive [Dry Creek Watershed Action Plan](#) that was developed in 2022 to improve the aquatic habitat and restore conditions to support a healthy macroinvertebrate community and remove Dry Creek from the impaired waters list.

#### 6.6.7.1 Dry Creek

Dry Creek [AU# 16-34-(0.7); WS-IV; NSW] from a point 0.3 miles downstream of Chatham County SR 1506 (Old Graham Rd.) to Haw River is impaired for aquatic life due to a Poor benthic macroinvertebrate community rating at station BB307 in 2018 (*Table 6-55*). Dry Creek received a Fair bioclassification in 2009. Benthic data collected at the station since 1986 suggests this stream's flow likely slows or ceases annually. This would be the most obvious cause of lower biological diversity here since habitat features appear within normal ranges and there are no permitted NPDES dischargers upstream from this location. Other factors that may affect benthic metrics at this location include flow fluctuations, nonpoint source runoff from recent large residential construction projects and beaver dams leading to reduced flow and low dissolved oxygen values downstream.



Only seven EPT taxa were collected in Dry Creek in 2013. This was the lowest EPT richness (7) and abundance (20) recorded at this sampling station since 1986. Dry Creek at SR 1520 was assigned a bioclassification of Not Rated in 2013 due to the presence of a beaver dam upstream that likely contributed to the low dissolved oxygen value observed. Additional beaver activity was observed downstream from the sample reach. The only common EPT taxa observed at this location included the mayfly *Stenacron interpunctatum*, the stonefly *Perlesta* and the caddisfly *Cheumatopsyche*. Forest cover in this catchment has slowly decreased from 73% in 1992 to 53% in 2006.

BB307	
Year	Bioclassification
1993	Good
1998	Good-Fair
2003	Fair
2009	Fair
2013	Not Rated
2018	Poor

Dry Creek received a Poor benthic bioclassification in 2018 and likely continues to suffer from a variety of factors including extreme flow fluctuations that are common in smaller Slate Belt streams, increased development and limited riparian buffers leading to increases in nonpoint source pollution, particularly in

years with high amounts of rain such as in 2018. Future benthic samples from this location are recommended to assess water quality improvements or declines.

A [Dry Creek Watershed Action Plan](#) was developed by the Central Pines Regional Council (formally Triangle J Council of Government, or TJCOG) in cooperation with local stakeholders in 2021-2022. The purpose of the plan is to coordinate and guide watershed activities in order to restore and protect the watershed to support the designated uses- in this case, to support a healthy aquatic ecosystem. There are no NPDES wastewater surface water discharge, stormwater or animal feeding operation permits in this watershed. The Dry Creek watershed sits outside municipal boundaries resulting in the majority of the wastewater generated being treated using single-family septic systems. There are several single-family residence wastewater irrigation permits and residual solid waste application fields. The only piped wastewater in the watershed is a 50,000 gpd wastewater treatment plant operated by Aqua North Carolina, which distributes the waste as reclaimed water for irrigation on and around the Chapel Ridge Golf Course and community.

Dry Creek is almost exclusively impacted from nonpoint sources of pollution. The Dry Creek Watershed Action Plan summarizes known and potential pollution sources, organized into the following categories of stressors on benthic macroinvertebrate health:

- Land use changes and associated stormwater runoff contributing additional sediment, nutrients and potentially other wastewater-derived pollutants to Dry Creek and tributaries.
- Riparian buffer degradation on both residential and agricultural properties impacting aquatic/benthic habitat and decreasing interception/filtration of runoff to creeks.
- Agricultural nonpoint source pollution, primarily stemming from livestock access to creeks, contributing to streambank erosion and degradation of benthic habitat.
- Potential impacts of natural low flow regimes on benthic macroinvertebrates.

The Dry Creek Watershed Action Plan (6/30/2022) clearly describes the goals and objective of the plan and how management practices and strategies can be implemented in a timely manner to improve the aquatic habitat in this watershed. *DWR supports these efforts, and as resources allow, will participate in the implementation, stakeholder engagement, and monitoring to assess the water quality improvements over time.*

*DWR biologists recommended station BB307 remain on the basin monitoring schedule to assess water quality improvements as the watershed plan is implemented over time. Implementation of the Jordan Lake rules and BMPs to reduce sediment loading to Dry Creek is recommended.*

6.6.7.2 *Pokeberry Creek*

Pokeberry Creek (AU# 16-37; WS-IV; NSW) from the source to the Haw River is supporting for aquatic life due to an Excellent 2018 benthic macroinvertebrate (BB320) and a Good 2013 fish (BF109) community rating (*Table 6-55*). The Pokeberry Creek biological community is monitored at station BB320 on SR 1711; located approximately one mile west of Bynum and approximately one mile upstream from its confluence with the Haw River in Chatham County. Pokeberry Creek has been sampled seven times since 1985. The stream was rated Good in 1998 and Good-Fair in 2009. Previous reports noted the resilience of the benthic community at Pokeberry Creek through drought. The geology underlying Pokeberry Creek watershed is mainly granite rather than slate. This may account for the increased flows here compared with other nearby streams.



A significant decline in EPT richness was observed in 2013 compared to previous years of benthic sampling at this station; the site was Not Rated due to indications of scour and recent heavy storm events prior to sampling on May 20, 2013. Excluding seasonal taxa, EPT richness declined by eight taxa from 2009 to 2013. The significant loss of these more intolerant EPT taxa could suggest further silt and other nonpoint source pollutants from upstream anthropogenic sources. Per USGS land use data, development significantly increased in this catchment between 1992 and 2001 and has continued to increase. Land development activities may lead to increases in nonpoint source runoff pollutants, especially following rain events.

BB320	
Year	Bioclassification
1993	Good-Fair
1998	Good
2003	Good-Fair
2009	Good-Fair
2013	Not Rated
2018	Excellent
BF109	
2004	Good
2009	Excellent
2013	Good

Seasonally corrected EPT richness was 29 in 2018 allowing this sampling station to receive its first Excellent benthic bioclassification. The benthic community suggested water quality improvements compared to previous sampling years. EPT taxa intolerant to pollution disturbances were collected in 2018 and future sampling is recommended in Pokeberry Creek to assess future nonpoint source pollution inputs. Compared to most other Carolina Slate Belt streams, there is a high diversity of EPT taxa in Pokeberry Creek.

In 2013, fish community station BF109 was still affected by the late 2012-early 2013 drought. The number of fish collected has greatly declined from 722 to 524 to 195 since 2004 (a 73% decrease), and there was a very low percentage of species with multiple age classes, which is often seen in communities recovering from sustained and frequent droughts followed by very high flow. There was an eight-point decline in NCIBI score, and the one rating class decline was due to fewer species, loss of a species of darter, loss of intolerant species, and loss of age classes (nine of 19 species were represented by only 1 or 2 fish/species). In prior sampling years, BF109 had been an extremely diverse community for a stream of its size. This was related to the site's proximity to the river with species migrating to and from the river. However, the community is affected more so by persistent low flows and droughts, as are many Carolina Slate Belt

streams, than by changes in water quality. Continued basinwide assessment of this regional reference site should be done in future to document any potential impacts from increased development in the watershed.

### 6.6.7.3 Robeson Creek

Robeson Creek and its Turkey Creek tributary suffer from habitat degradation resulting in biological integrity impairment as well as elevated nutrients (Table 6-55). This is a DWR Use Restoration Watershed and has received significant attention from several watershed partnerships resulting in ongoing watershed restoration and conservation efforts over the years. These efforts have waned over the last few years.

In 2019, at station B245000, near the bottom of the watershed, the land use was approximately 74% forest, 8% agriculture, and 13% developed with an impervious cover of about 2.4% (2019 NLCD). This watershed is undergoing a serious change as the 7,068-acre Chatham Park development project is underway.

Table 6-55: Robeson Creek Watershed (030300020703) 2022 IR Use Support Summary.

Stream Name*	Assessment Unit (AU)	Description	Stream Length	Stream Classification	2022 IR# Rating	Stations Assessed
Dry Creek	16-34-(0.7)	From a pt 0.3 miles downstream of Chatham Co. SR 1506 to Haw River	10.1	WS-IV; NSW	Impaired; Benthos (5)	BB307
Pokeberry Creek	16-37	From source to Haw River	8.0	WS-IV; NSW	Supporting	BB320, BF109
Robeson Creek	16-38-(1)	From source to a point 0.7 miles downstream of Chatham County SR 2159	2.63 mi	WS-IV; NSW	No Data	NA
Robeson Creek	16-38-(3)a	From a point 0.7 miles downstream of Chatham County SR 2159 to Pittsboro Lake	0.90 mi	WS-IV; NSW	Impaired; Benthos (5)	1998 listing for benthos
Robeson Creek	16-38-(3)b	Pittsboro Lake	16.73 ac	WS-IV; NSW	No Data	NA
Robeson Creek	16-38-(3)c	From Pittsboro Lake to UT across from SR 1951	2.40 mi	WS-IV; NSW	Impaired; Benthos (5)	BB070, BB069, BB012, BB045, BB065, BB016
Robeson Creek	16-38-(3)d	From UT across from SR 1951 to next AU.	3.10 mi	WS-IV; NSW	Supporting	BF16, BB189
Robeson Creek	16-38-(5)	From a point 0.3 miles upstream of mouth to Robeson Creek Arm of Jordan Lake	0.66 mi	WS-IV; CA; NSW	No Data	NA
Robeson Creek	16-(37.5)b	Robeson Creek Arm of Jordan Lake	46.62 ac	WS-IV; CA; B; NSW	Impaired; Chl a & Turbidity	B2450000
Turkey Creek	16-38-4	From source to Robeson Creek	4.11 mi	WS-IV; NSW	Impaired; Benthos (5)	BB226, BB423
Camp Creek/UT to Roberson Cr.	16-38-(3)cut6	From source to Robeson Creek	4.32 mi	WS-IV; NSW	Supporting	BB052, BB520
Hill Creek	16-38-2-(1) & 16-38-2-(2)	From source to Roberson Creek	1.86 & 0.29 mi	WS-V; NSW	No Data	NA

\*All waterbodies (named and unnamed) in this subwatershed (030300020703) are subject to the Total Phosphorus TMDL and the Jordan Lake Management Strategy.

# Integrated Report (IR) is updated every two years. 2022 IR data window is 2016-2020. For the most up to date listing see the Modeling and Assessment Branch [Integrated Reports webpage](#).

In 2004, EPA approved a total phosphorus TMDL for Robeson Creek. A 71% reduction in the total phosphorus load from both point and nonpoint sources is required in order to achieve the chlorophyll *a* standard in the Robeson Creek arm of Jordan Lake (at station B2450000).

The Town of Pittsboro's wastewater treatment plant (NC0020354) is currently the only NPDES point source discharger to Robeson Creek about 7.0 miles upstream from Jordan Lake arm (see permitting details below).

A TMDL special study was completed in 2001-2002 which identified nonpoint sources in this subwatershed to be agricultural (cropland and pasture/hay land), urban (streets, lawns, roofs, driveways, parking lots and sewers) and forest land. Fertilizer applications to lawns were identified as a major source of TP to Robeson Creek.

It was also noted that runoff and shallow subsurface flow from Townsend Foods Inc. irrigation spray fields appeared to transport phosphorus to Turkey Creek, Camp Creek and other unnamed tributaries that ultimately drain to Robeson Creek. A benthic macroinvertebrate study was completed in 2001 that determined runoff from the irrigation fields had adversely affected the benthic communities in Turkey and Camp creeks ([Table 6-56](#)). Townsend Foods had a non-discharge spray permit (WQ0001755) that allowed the facility to spray wastewater from the lagoon onto fields that drain to Turkey and Camp creeks. In 2004, Townsend Foods began operating a wastewater recycling facility which reduced the amount of process wastewater generated and resulted in less wastewater sprayed from the holding lagoon onto the fields that drain to Turkey and Camp creeks. Townsend Foods was also required to develop a Stormwater Pollution Prevention Plan as part of their general stormwater permit that covers the stormwater runoff from their main facility area that drains directly to Turkey Creek.

The chicken processing plant was started in 1965 and in operation through November 2011. In March 2014, the permit (WQ0001755) was modified to reflect Chatham Park Investors, LLC as the new owner of the reclaimed water treatment plant, the treatment lagoon and spray fields only. The treatment plant has been dismantled and the lagoon is in the process of being closed. Two groundwater wells with total dissolved solids and chloride concentrations exceeding NC groundwater standards were identified and a Groundwater Corrective Action Plan is being prepared for submittal and approval by DWR.

A benthic macroinvertebrate study was also completed by DWQ in May 2009. Both Camp Creek and Turkey Creek were sampled upstream and downstream of an unnamed tributary draining Townsend Foods spray fields ([Table 6-56](#)).

Upstream and downstream of the unnamed tributary to Camp Creek are Supporting aquatic life due to a Good benthic macroinvertebrate bioclassification at stations BB226, BB052 and BB520 respectively ([Table 6-55](#) and [Table 6-56](#)). The downstream community was a borderline Good/Good-Fair. Several more pollutant-tolerant species, known to be indicators of nutrient enrichment and organic pollution, were collected at the downstream station. The unnamed tributary to Camp Creek also had a high conductivity reading (326  $\mu\text{mhos/cm}$ ) which caused the downstream Camp Creek station to have a higher conductivity level compared to the upstream station (124 vs. 97  $\mu\text{mhos/cm}$ ).

Turkey Creek was found to be impaired due to a Fair benthic macroinvertebrate community both upstream (BB423) and downstream (BB226) of the unnamed tributary (*Table 6-55* and *Table 6-56*). The Fair bioclassification upstream was likely due to a narrow riparian zone, leading to decreased canopy cover, increased erosion, and sedimentation. A slightly more tolerant community, higher conductivity and lower dissolved oxygen levels suggested degraded water quality at the downstream station was possibly due to influences from the spray fields. Although wastewater is no longer sprayed on the fields, it is possible that residual nutrients still seep from the fields.

*Table 6-56: Robeson Creek Watershed (HUC-12 030300020703) Biological Assessment Results.*

Stream Assessed	Assessment Unit (AU)	Station # Benthic (BB)/Fish (BF)	Year	Bioclassification	Station Location
Robeson Creek	16-38-(3)c	BB070	1997	Fair	US 15-501
Robeson Creek	16-38-(3)c	BB069	1997	Fair	Near Horton St.
Robeson Creek	16-38-(3)c	BB012	2001	Fair	Near Taylor St.
Robeson Creek	16-38-(3)c	BB045	2001	Fair	Near E Cornwallis Rd.
Robeson Creek	16-38-(3)c	BB065	1990	Fair	Near Fairgrounds Rd.
Robeson Creek	16-38-(3)c	BB016	2001	Fair	Near Turkey Creek
Robeson Creek	16-38-(3)d	BB189	2001	Good-Fair	Near SR 1943
Robeson Creek	16-38-(3)d	BF16	2003	Good	Near SR 1943
Turkey Creek	16-38-4	BB423	2001 2009	Not Rated Fair	US 15-501
Turkey Creek	16-38-4	BB226	2001 2009	Not Rated Fair	SR 1012
Turkey Creek	16-38-4	BB227	2001	Not Rated	SR 1012
Camp Creek*/UT to Roberson Cr.	16-38-(3)cut6	BB226	2001 2009	Not Rated Good	SR 1012 Upstream of UT to Camp Cr.
Camp Creek*/UT to Roberson Cr.	16-38-(3)cut6	BB520	2009	Good	SR 1012 Downstream of UT to Camp Cr.
Camp Creek*/UT to Roberson Cr.	16-38-(3)cut6	BB052 Special Study	2009	Good	SR 1012 Upstream of UT

\*Camp Creek is officially an Unnamed Tributary (UT) to Robeson Creek

In 2003, the Robeson Creek Watershed Council (RCWC) was formed from several stakeholder efforts in the watershed. The RCWC coordinated a significant amount of work in the watershed including the development and implementation of the phosphorus TMDL. It should also be noted that they were trying to address the other impairments (i.e., biological integrity) while addressing the phosphorus loading issue. Details of the plan development and activities can be found in the Robeson Creek Watershed Restoration Plan ([NC Watershed Restoration Plans](#)).

RCWC coordinated macroinvertebrate benthic monitoring that occurred on Turkey, Camp and Robeson creeks during the 2008-2010 time period. The mainstem of Robeson Creek was monitored once for fish by DWR at station BF16 [AU# 16-38-(3)d] in 2003, when it received a bioclassification of Good. Results

from this monitoring indicated that the water quality has neither declined nor improved significantly since the previous studies.

For a short time, RCWC, also collected physical and chemical water quality data from eight monitoring stations interspersed throughout the subwatersheds. According to the data collected at the most downstream station (about two miles upstream of B2450000) in the watershed, the annual total phosphorus loads ranged from 31 to 50% less during 2005-2009 compared to 2004, while annual discharge for the same period was 8 to 37% less. These data also indicated a reduction in total Kjeldahl and inorganic nitrogen while changes in TSS were mixed for the period of 2005-2009. It should be noted that some of these reductions could be attributed to the drought that occurred during that time period. According to town staff, RCWC is no longer active, and the watershed restoration plan is not currently being implemented. The town however indicated their interest in applying to DEQ-DWI for fall 2022 ARPA grant funding to establish a watershed master plan which could include asset inventory and conditions assessment of their current stormwater infrastructure and a capital improvement plan. This would allow the Town of Pittsboro to establish a long-range plan and update town ordinances that will address historical flooding issues while working with development to ensure the preservation of the watershed (Morgan DeWit, email communication, August 2022).

The TMDL compliance site is at ambient monitoring station B2450000 in the Robeson Creek Arm of Jordan Lake [AU#16-(37.5)b]. The TMDL reported that the historical watershed data indicated elevated nutrients, high algal productivity and frequent nuisance algal blooms. The current (2022 IR) ambient monitoring data indicate that this station is still impaired due to chlorophyll *a* (30% exceedance), and turbidity (20% exceedance) standard violations (*Table 6-55*). Both ambient monitoring programs have collected samples at this location; however, the UCFRBA terminated monitoring in May 2010.

The data from both ambient monitoring programs were combined for the purpose of assessing the changes that have occurred at this location over the last 30 years. DWR conducted a seasonal Mann-Kendall trend test for total phosphorus at station B2540000, which resulted in a significant decreasing trend for data collected from 1990-2019 and 2000-2019, but not for 2010-2019 (calculated at 95% confidence) (*Table 6-27*). The 2004 TMDL requires a 71% reduction in total phosphorus loading.

As seen in *Figure 6-114*, the five-year mean instream total phosphorus concentrations have decreased 45% from the 2000-2004 mean concentration of 0.131 mg/L and 51% from the 1990-1994 mean concentration of 0.147 mg/L. This is a good indicator that actions in the watershed have reduced the total phosphorus loading but that it has leveled off over the last 10 years. These same assessments for total nitrogen, turbidity and chlorophyll *a* concentrations have not seen the same reductions as a result of the actions put in place to address the total phosphorus TMDL (*Figure 6-114*). Additional efforts will be needed to address nitrogen and turbidity especially in an urbanizing watershed.

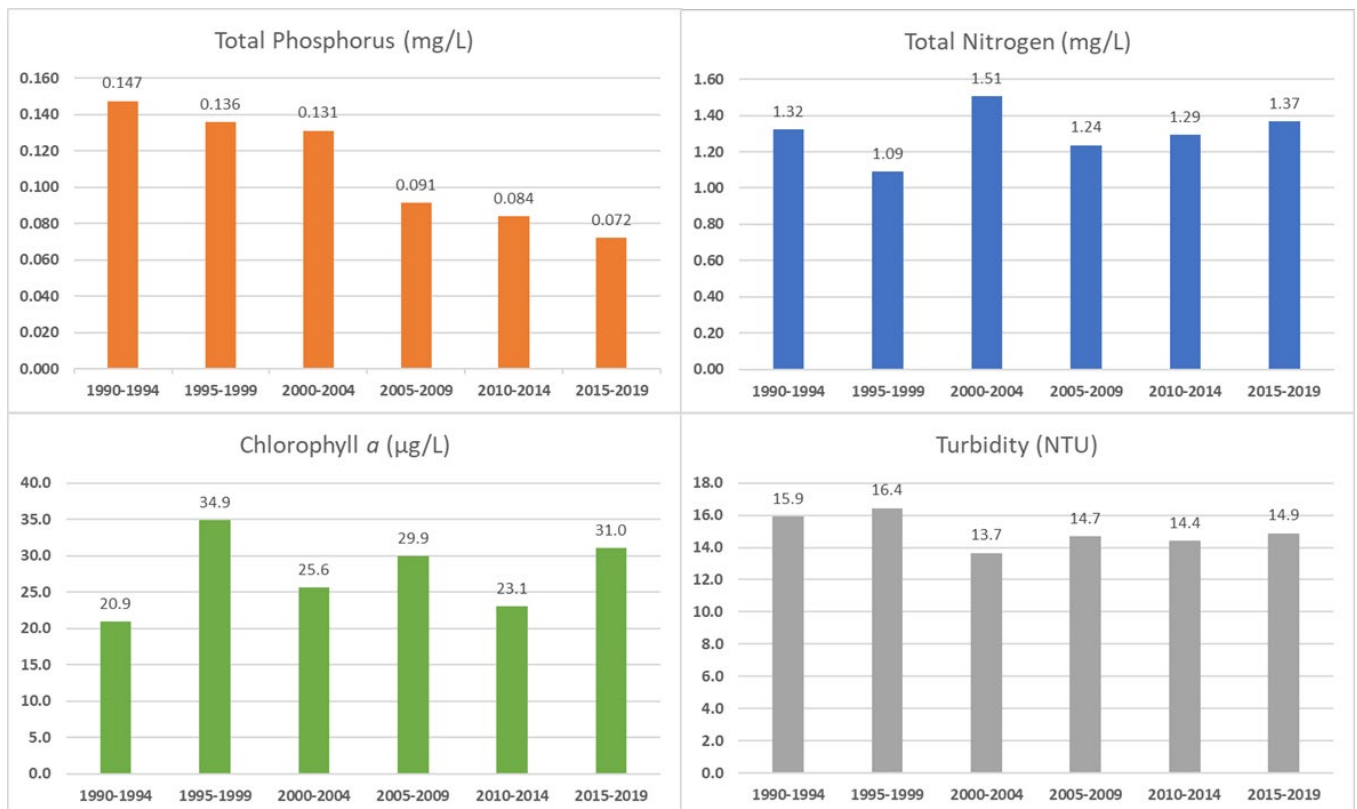
In 2021, two additional ambient monitoring stations were added to the mainstem Robeson Creek as a result of Chatham Park Investors LLC joining the Upper Cape Fear River Basin Association coalition program. As described below, the Chatham Park development project will construct a wastewater treatment plan with a discharge to Robeson Creek [in segment AU# 16-38-(3)c]. The coalition added a station (B2300000) at highway 15 in Pittsboro, about 0.7 miles upstream of the wastewater discharge

point. DWR agreed to also add an ambient monitoring station (B2420000) near White Mobile Home Park Road, about 1.6 miles downstream of the wastewater treatment discharge site (~0.6 miles below the confluence with Turkey Creek).

Physical Parameters	Chemical Parameters	Biological Parameters
Dissolve Oxygen	Nitrogen – TN, NO <sub>2</sub> +NO <sub>3</sub> & TKN	Fecal Coliform Bacteria
pH	Total Phosphorus	Chlorophyll- <i>a</i>
Specific Conductance	Total Suspended Solids	
Temperature	Turbidity	

The parameters assessed at these two stations will include physical, chemical and biological parameters. The addition of these two ambient monitoring stations will help DWR assess changes in water quality as result of increased wastewater effluent and the expected impacts from the increased development pressures. The goal is to understand how the changes in the watershed and the best management measures put in place to protect the environment are working and reflected in water quality over time. As of 2022, this section of Robeson Creek was impaired for aquatic life due to a Fair benthic macroinvertebrate community throughout this 2.4 mile section of the creek (*Table 6-55* and *Table 6-56*). As resources allow, it is recommended that these biological stations be reassessed.

*Figure 6-114: Robeson Creek Five-Year Mean Concentrations at Station B2450000 (Robeson Creek Arm of Jordan Lake) for Total Phosphorus, Total Nitrogen, Chlorophyll a and Turbidity.*



**Robeson Creek point source permit information:**

There is a single surface water NPDES discharge permit in Robeson Creek (NC0020354). Chatham Park Water Recovery Center, formally known as Chatham Park Decentralized WRRF received a permit in February 2018 to construct a non-discharge facility (WQ0039375). The Town of Pittsboro and Chatham Park Water Recovery Center (CPWRC) applied as co-permittees for the modification and renewal of the surface water discharge permit NC0020345 which became effective June 1, 2022.

The Town of Pittsboro is currently permitted to discharge to Robeson Creek (outfall 001A; 0.75 MGD) and the has ability to expand and discharge to a secondary outfall 002 on the Haw River (1.971 MGD) (*Table 6-57*). In 2011, a permit modification was approved for the addition of the Haw River discharge. In response to concerns from the community, the Town of Pittsboro agreed to effluent limits for fecal coliform at reclaimed water effluent standard of 14/100 mL as a monthly average and 25/100 mL as a weekly average in their Haw River effluent (outfall 002).

CPWRC as a co-permittee to the permit will be upgrading their non-discharge treatment plant in order to discharge 0.499 MGD through the existing Town of Pittsboro’s outfall 001 to Robeson Creek. The permit contains two outfalls: Outfall 001 (001A & 001B – divided between the two entities) to Robeson Creek and Outfall 002 to the Haw River (*Table 6-57*).

*Table 6-57: Town of Pittsboro and Chatham Park Water Recovery Center NPDES Permit (NC0020354) Current and Future Effluent Flow and Receiving Streams.*

Owner	Outfall # <sup>1</sup>	Receiving Stream	Current Flow <sup>2</sup> (MGD)	Future Flow (MGD)	Note
Town of Pittsboro	001A	Robeson Creek	0.75	0.75	Phosphorus limits; Nitrogen & Phosphorus load limits
Chatham Park Water Recovery Center	001B	Robeson Creek	0	0.499	The load from CPWRC is added together with Pittsboro’s to meet TMDL load limits
Town of Pittsboro	002	Haw River	0	1.971	Special fecal coliform limits; Nitrogen & Phosphorus load limits
<b>Total Flow</b>				<b>3.22</b>	<b>Total allocation is 36,202 lbs/yr TN &amp; 4,551 lbs/yr TP</b>

1. Outfall 001 is the combination of 001A + 001B.

2. Current flow as of August 2022.

The permitted nutrient discharge is governed by both the Robeson Creek total phosphorus TMDL and the Jordan Lake Nutrient Management Strategy. The current permitted allocation is 36,202 lbs/yr TN and 4,551 lbs/yr TP. Due to Robeson Creek TP TMDL, the Town is only allowed to discharge up to 322 lbs of TP during the summer months (April to October) via outfall 001. As of 2022, combined Pittsboro/CPWRC is discharging well below their permitted allocation (*Table 6-58*).

The Town of Pittsboro also maintains a water reuse non-discharge permit (WQ0024838) which provides up to 0.3 MGD of treated wastewater to an industrial facility. This permit was modified in 2021 to allow

for reclaimed water from the current operation of the CPWRC non-discharge facility (WQ0039375) to be conveyed to the Pittsboro WWTP and distributed under their permit.

*Table 6-58: Town of Pittsboro WWTP and Chatham Park Water Recovery Center’s Annual Total Nitrogen and Total Phosphorus Jordan Lake Allocation and their Yearly Load between 2019 and 2022. Includes the Delivery Factors for their Robeson Creek Outfall 001 (A and B) and Town of Pittsboro’s Future Haw River Outfall 002.*

<b>Pittsboro WWTP NC0020354</b>	<b>Total Allocation lbs/yr</b>	<b>Delivery Factor Outfall 001 Robeson Cr.</b>	<b>Delivery Factor Outfall 002 Haw River</b>	<b>2019 lbs/yr</b>	<b>2020 lbs/yr</b>	<b>2021 lbs/yr</b>	<b>2022 lbs/yr</b>
<b>Total Nitrogen</b>	32,202	76%	99%	11,011	12,701	11,115	9,923
<b>Total Phosphorus</b>	4,551	82%	99%	344	323	791	548

Jordan Lake nutrient strategy (15A NCAC 02B .0270)

The Town of Pittsboro is proposing a major upgrade of their treatment plant which requires multiple steps to achieve their desired treatment plant capacity and treatment efficiency. These are described in their June 2022 permit.

The town has an agreement with the City of Sanford’s Big Buffalo WWTP (NC0024147) allowing up to 2.0 MGD of untreated wastewater to be diverted to the Big Buffalo WWP from the Pittsboro WWTP.

The following are steps identified in the permit for the Town of Pittsboro and the CPWRC:  
Pittsboro –

1. Construct a 2 MGD force main to Big Buffalo Creek WWTP
2. Decommission the existing Pittsboro WWTP
3. Construct and operate a 2.721 MGD wastewater treatment facility
4. Construct outfall 002 in Haw River (1.971 MGD)

Chatham Park Water Recovery Center –

1. Develop a direct wastewater discharge facility
2. Connection of necessary sewer lines to the Town of Pittsboro’s collection system for discharge through outfall 001B in Robeson Creek (0.499 MGD)

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*Update to the NPDES permit information for the Town of Pittsboro as of February 2025.*

*In August 2023, City of Sanford and Town of Pittsboro signed an interlocal agreement to merge drinking water, reclaimed water, and sewer systems and as of July 1, 2024, the merger was complete and the utility is now TriRiver Water. The official NPDES permit modification occurred on July 10, 2024 with the transfer of ownership and name change on permit (NC0020354) to City of Sanford and Chatham Park Investors LLC (DWR July 10, 2024 transfer of ownership document). All remaining requirements of the discharge permit remains the same.*

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*Additional updated information:*

Based on a January 21, 2025, [letter](#) from TriRiver Water to DWR in response to a permit notice of violation (for September 2024; NOV-2024-LV-0990) due to excess influent flow that exceeded the Pittsboro WWTP design capacity as result of high rainfall levels from Tropical Cyclone 8 and Tropical Storm Helene in 2024. The monthly rainfall total was approximately 10 inches. TriRiver Water indicated “there are currently plans to build a new lift station and force main that would intercept flow to the Pittsboro WWTP and divert it to the Sanford WWTP, allowing for flow leveling at the Pittsboro facility. This will aide the Pittsboro facility in its ability to adequately treat incoming wastewater.” TriRiver Water also indicated there are two additional collection system projects underway to address inflow and infiltration (I&I).

1. Development of a wastewater master plan that includes flow monitoring to help identify and prioritize the areas of the system with the highest I&I.
2. A \$4.45 million [Find It – Fix It Sewer Rehabilitation Project](#) (SRP-W-ARP-0144) grant provided by the NC allocation of the American Rescue Plan Act of 2021. This project will locate and repair leaks and defects in more than 26,000 linear feet of sewer infrastructure in Pittsboro.

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*Recommended actions to take in Robeson Creek and other urbanizing watersheds throughout the Cape Fear River Basin:*

State stormwater control programs have traditionally focused on detaining and treating runoff to remove pollutants it carries before releasing it offsite. As development continues in North Carolina, it has become increasingly apparent that protecting the integrity of receiving waters from post-construction stormwater runoff is more challenging than originally imagined. Research has shown that an important impact associated with development that has been underrepresented is the sheer increase in runoff volume it generates. The resulting “flashier flows” following storm events can erode and destabilize stream channels over time, creating a cascading effect downstream. Unstable streams also export excess amounts of nutrient-containing sediment, adding to nutrient over-enrichment problems downstream in slow-flowing areas, especially reservoirs and estuaries.

To better protect receiving streams in growing areas of the basin, communities are encouraged to consider strengthening post-construction stormwater control requirements beyond state minimums requiring detention, treatment and release of runoff from 1” rainfall events. In most Piedmont settings, development tends to yield significant increases in volumes of runoff due to impervious surfaces and other land modifications. These increases are not significantly diminished by prevailing conventional runoff treatment practices such as wet detention ponds. Requirements to capture a larger storm volume, like the pre- to post-development difference for the one-year, 24-hour event, and to provide some amount of volume reduction along with treatment before discharge would dampen these large increases in runoff. State stormwater programs have established the concept of runoff volume matching as an acceptable compliance alternative that addresses this issue. Less rigorous standards that provide some runoff volume reduction would still improve upon current state minimums.

Another aspect of state minimum stormwater requirements that communities can improve upon to better protect streams is the density threshold built-upon area where capture and treatment of runoff is required. The typical high-density threshold of 24% built-upon area that applies in most areas has been shown to be well above a protective threshold for stream integrity. One well-known study determined that watershed impervious levels above 10%, left unmitigated, tend to degrade stream integrity. Communities in growth areas are encouraged to consider requiring treatment at intensities below this 10% level. Particularly in areas where streams are already impaired. In the watersheds of nutrient-impaired waterbodies, such as Jordan and Randleman lakes, more stringent stormwater controls are a pressing need, as growth will further exacerbate these problems.

The emerging community of Chatham Park is one such growth area where tighter stormwater controls would be important and should be considered by community leaders. The developer for Chatham Park has established an incentive structure that identifies a range of potential post-construction controls that developers might choose from that are above minimums established by the state, including volume-reducing practices. However, the choice of any of these options is voluntary, and stormwater control is only one element of an overall “exceptional development” point system, providing little certainty that further degradation will be avoided to the receiving stream (Robeson Creek). Robeson Creek is impaired for benthic macroinvertebrates and nutrients. Robeson Creek is a tributary to Jordan Lake which is also impaired and a nutrient over-enriched system. Making greater runoff volume reduction a necessary or required element of development designs would go a long way toward stemming further degradation of these impaired waterbodies.

DWR encourages community leaders and developers to maximize the use of low-impact development (LID) designs and distribute stormwater control measures throughout the community in such a way that it maximizes runoff volume reduction to a volume that matches pre-development conditions. Maximizing the use of nutrient reducing stormwater controls will also decrease the amount of nitrogen and phosphorus leaving the site and impacting already over-enriched systems. Several tools are available to help community leaders identify stormwater practices that reduce runoff and match pre- and post-construction runoff volumes including DEMLR’s [Stormwater Design Manual](#) and the Wildlife Resources Commission’s (WRC) [Green Growth Toolbox](#).

When resources allow, add Robeson Creek watershed to the biological basinwide monitoring efforts to capture impacts from the large Chatham Park development. We would recommend Robeson Creek stations BB016, BB189 and BF16; Turkey Creek stations BB227 or BB226; and Camp Creek station BB520.

In the Robeson Creek watershed, all waters are subject to two TMDLs which address the need to reduce nitrogen and phosphorus from making their way into surface waters. Actions need to be taken by all nutrient producing sectors to implement nutrient reducing BMPs. The TP TMDL specifically identified lawn fertilizers as a source which needs to be addressed as well. The town, Chatham Park, county extension, SWCD staff and others should develop educational materials for local citizens and homeowners to reduce over-application of nitrogen and phosphorus fertilizers, encourage the use of soil tests, and limit application near surface waters as well as applying too close to the edge of roads and driveway surfaces.

It is recommended that the Town of Pittsboro work with stakeholders to find a watershed champion to implement and, if needed, update the Robeson Creek Watershed Restoration Plan which address stressors identified throughout the watershed impacting water quality and nutrient runoff as needed to comply with the TMDLs.

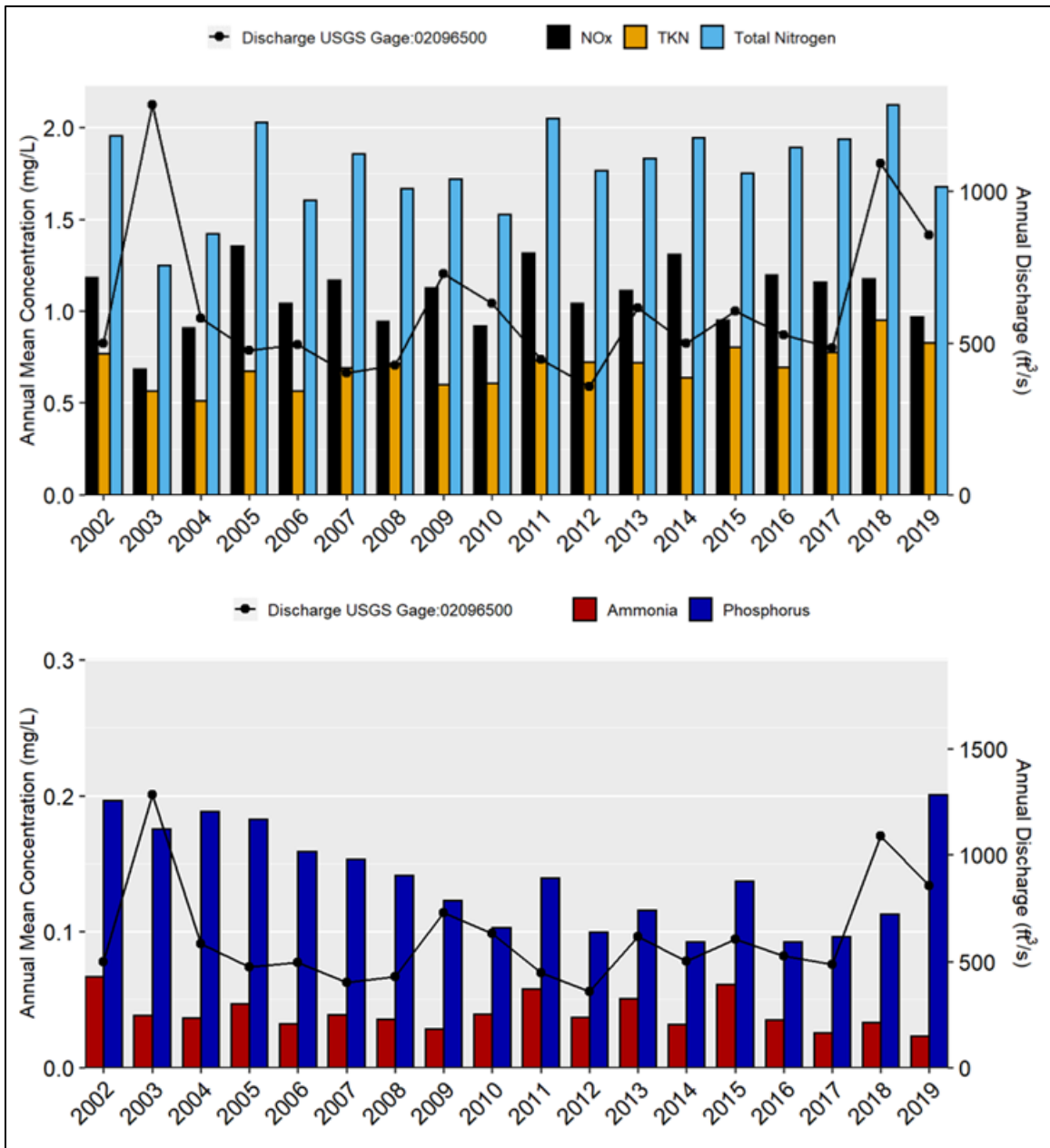
#### *6.6.7.4 Haw River Mainstem including Haw River Arm of Jordan Lake*

The approximate 8.7 miles of the Haw River in the Robeson Creek watershed (HUC 0303000207) runs from the HUC 205/207 boundary just downstream of Terrells Creek (North side) to a point 0.5 miles downstream of US Hwy 64 (*Figure 6-16*). This stretch of the Haw River includes the Town of Pittsboro's water supply watershed and intake, a co-located ambient monitoring station (B2100000) near Bynum, and a benthic macroinvertebrate station (BB443) at US Hwy 64 which is location of the Town of Pittsboro's future wastewater discharge location (outfall 002)(*Table 6-24* and *Table 6-54*). Currently there are two minor wastewater dischargers (Bynum WWTP and Pittsboro WTP).

AMS station B2100000 captures the influence from Dry, Brooks and Wilkinson creeks as well as the entire Haw River watershed upstream and is located very close to the USGS flow gage at Haw River near Bynum (02096960). This is approximately 29.5 miles downstream from the Haw River at Haw River NC USGS gage (at AMS B1140000 and USGS # 02096500).

Overall, nutrient concentrations are lower in this segment of the Haw River as the five-year mean TN and TP concentrations were 1.86 mg/L and 0.12 mg/L respectively at B2100000, compared to 2.12 mg/L and 0.11 mg/L at the upstream station B2000000 (*Table 6-27*). The TN concentrations vary somewhat from year to year; the overall yearly and five-year means have not change much over the last 20 years (*Figure 6-83* and *Figure 6-115*). Similar to upstream, a significant decline in the total phosphorus concentration between 2000-2019 using a seasonal Mann-Kendall trend analysis has been identified (calculated at 95% confidence). The TP concentrations have leveled off with no trend identified seen between 2010-2019 (*Figure 6-83, Figure 6-115* and *Table 6-27*).

Figure 6-115: Haw River Ambient Monitoring Station B2100000 (near Bynum, NC) Annual Mean Nitrogen Constituent (NO<sub>x</sub>, TKN, TN) and Ammonia and Total Phosphorus Concentrations between 2002 and 2019.



Flow at USGS Gage Station 02096500 (Haw River, NC) Superimposed for Annual Streamflow Comparison.

While the instream nitrogen and phosphorus concentrations are lower than the Haw River segments between Hopedale and Swepsonville, the nitrogen and phosphorus concentrations (at station B2100000) are well above the instream concentrations in the headwater Haw River (B0040000), with TN and TP, 3.5 and 3 times higher, respectively (Table 6-27).

The five-year mean concentrations (*Table 6-27*) for fecal coliform bacteria (515 cfu/100 ml) and turbidity (21 NTU) are very similar to the upstream concentrations where TMDLs are being implemented. The influences on bacteria and turbidity are similar to those described above in the upstream Haw River HUC (0303000204) (section 6.6.4). Implementation measures identified to reduce loading of bacteria and sedimentation should be applied throughout the Robeson Creek – Haw River watershed (0303000207) as well. During the 2022 IR period, fecal coliform bacteria exceeded the 400 cfu/100 mL standard 17.6% of the time and the turbidity exceeded the 50 NTU standard approximately 7% of the time. The 5-year mean concentrations were higher in 2015-2019 than in the previous three 5-year periods, indicating that conditions are continuing to decline and there is a need to implement BMPs to reduce contributions from all sources in the watershed, especially those related to stormwater runoff (*Figure 6-83*).

Station B2100000 is co-located with the USGS stream gage. Flow separated analysis provides a more in-depth assessment of how flow directly impacts the concentrations of nutrients and other water quality parameters at this station (*Table 6-59* and *Figure 6-116*).

The mean and median concentration of NO<sub>x</sub>, conductivity, and chloride are higher at low flows ( $\leq$  25<sup>th</sup> percentile flows;  $\leq$  248 cfs), indicating that the sources influencing the instream concentration during low flow period are likely influenced by point source discharges (*Table 6-59* and *Figure 6-116*). The higher pH at low flows is likely the result of higher instream productivity which tends to occur during the warmer, lower-flow months, setting up conditions favorable for algal and periphytic production (*Table 6-59*).

*Table 6-59: Haw River Seventeen Year (2002-2019) Flow Separated/Dependent Mean Concentrations at AMS Station B2100000 using Flow from USGS Gage 02096960.*

Water Quality Parameter	Low Flow	Medium Flow	High Flow
Flow (cfs)	$\leq$ 248	249-1159	$\geq$ 1160
Turbidity (NTU)	4.3	11.7	<b>48.5</b>
TSS (mg/L)	6.7	8.5	<b>46.9</b>
Fecal Coliform (cfu/100 mL)	58	125	<b>1341</b>
NO <sub>x</sub> (mg/L)	<b>1.49</b>	1.06	0.67
TKN (mg/L)	0.77	0.61	<b>0.83</b>
NH <sub>3</sub> (mg/L) (% Non-detects*)	0.029 (60.9%)	0.036 (50.2%)	<b>0.066</b> (20.7%)
TP (mg/L)	0.13	0.11	<b>0.18</b>
Conductivity ( $\mu$ s/cm @25°C)	<b>355</b>	204	133
pH	<b>8.3</b>	7.7	7.2
DO (mg/L)	9.5	10.2	<b>10.3</b>
Chloride <sup>^</sup> (mg/L)	<b>37</b>	27	12

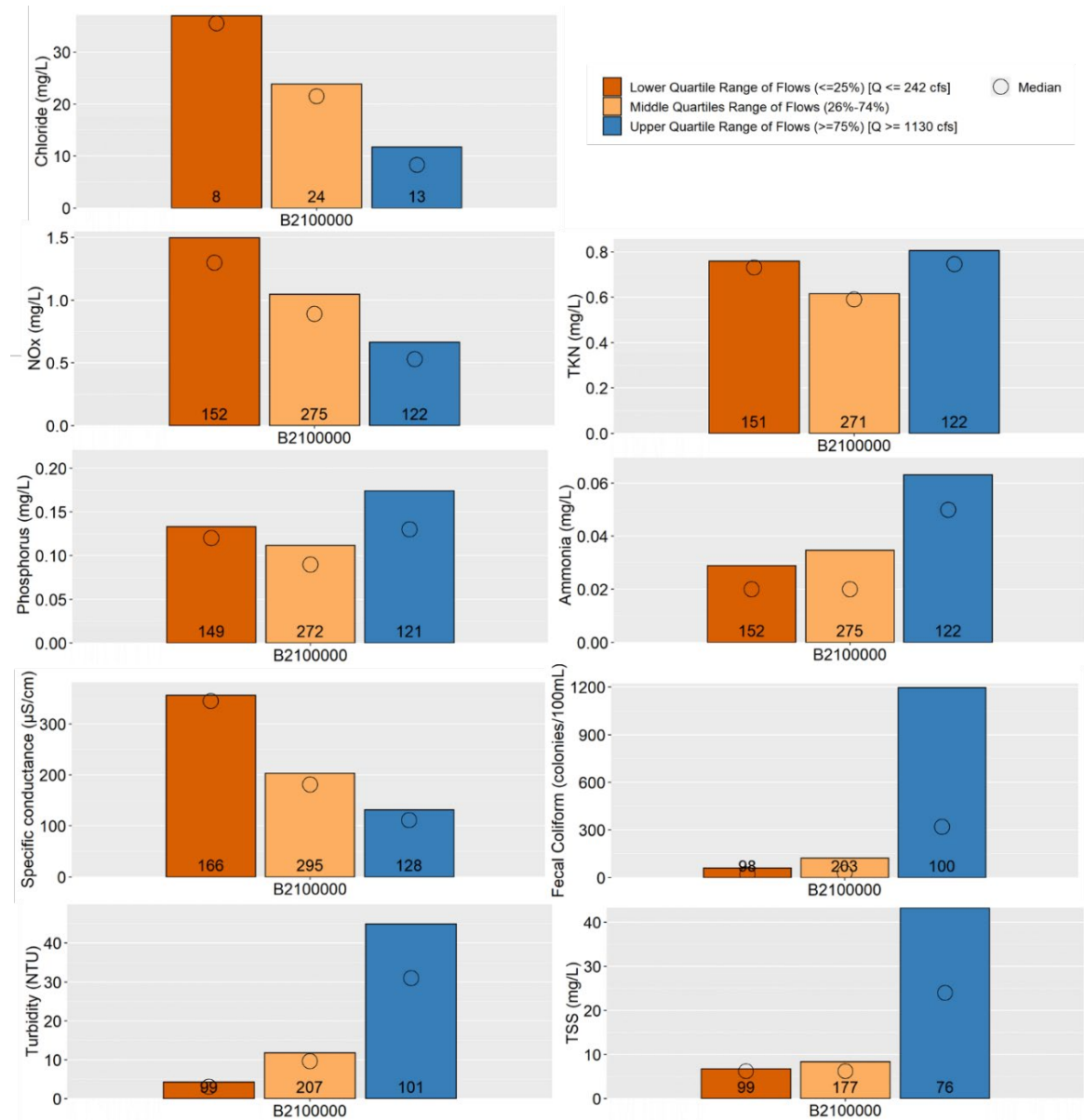
\*A large percentage of ammonia records are below the level of detection. The detection level is used in the summary analysis.

<sup>^</sup> Chloride was monitored only 35 times at B2100000 between 2014 and 2019.

**Note** - Haw River at Bynum; Low flows  $\leq$  25<sup>th</sup> percentile; Medium flows between 26<sup>th</sup> and 74<sup>th</sup> percentile; High flows  $\geq$  75<sup>th</sup> percentile.

Whereas turbidity, TSS, fecal coliform bacteria, TKN, TP and ammonia concentrations are higher at high flows ( $\geq 75^{\text{th}}$  percentile flows;  $\geq 1160$  cfs) indicating nonpoint source runoff as the source for most of these parameters (Table 6-59 and Figure 6-116), the sources of ammonia and TKN during high flow events could be related to wastewater treatment plant issues from high inflow and infiltration (I&I) issues due to leaky wastewater collections systems. These leaky systems can, in turn lead, to sanitary sewer overflows or treatment plant upsets.

Figure 6-116: Flow Separated Mean Concentrations at AMS Station B2100000 (2002-2019) using Flow from USGS Gage 02096960.



Section 6.3 for data analysis description. High flows  $\geq 75^{\text{th}}$  percentile; Medium flows between  $26^{\text{th}}$  and  $74^{\text{th}}$  percentile; Low flows  $\leq 25^{\text{th}}$  percentile at USGS Gage Station 02096960. Flow estimate based on 1991-2020 data.

According to the DWR Basin Information Management System (BIMS) database, the average Haw River flow was estimated to be 1275 cfs with a summer 7Q10 of 37.5 cfs (at the Bynum WWTP discharge point; BIMS pull 12/14/2022). The cumulative total permitted as-built wastewater flow from the watershed above station B2100000 is 94.269 MGD (equivalent to 145.8 cfs from 6 major and 67 minor NPDES permits, *Table 6-60*). The full permitted as-built flow would be about 11.4% of the annual mean flow of the Haw River near Bynum, NC and at low flows (7Q10), the majority of the stream flow is likely treated wastewater.

The influence of wastewater on nitrogen is most apparent during low flows but can also be seen in the changing TN concentrations in the mainstem Haw River. The highest average instream NOx and TN concentrations occur in the Haw River between Hopedale (B1020000, below the confluence with Reedy Fork) and Swepsonville (B1440000) with concentrations ranging between 1.67 and 1.95 mg/L NOx and between 2.67 and 2.91 mg/L TN (*Table 6-27*). This is the area with the highest wastewater discharge per square mile in the mainstem Haw River of 0.134 to 0.119 MGD/mi<sup>2</sup> (*Table 6-60* rows highlighted in orange). The instream TN and NOx decline as the as-built discharge per square mile declines.

*Table 6-60: Haw River Mainstem Water Quality Station NPDES Discharge Permit Analysis (Haw River Subset from Chapter 3 Appendix).*

Haw River Station ID	Drainage Area MI <sup>2</sup>	Major Permits	Minor Permits	Total Permits	Total Permitted As-built (MGD)	Total As-built / Drainage Area
B0050000	79.6	0	3	3	0.060	0.001
B0170000	168.4	1	8	9	7.616	0.045
B0210000	188.3	1	9	10	7.628	0.041
B1020000	478.7	2	26	28	64.159	<b>0.134</b>
B1140000	603.3	3	27	30	76.184	0.126
B1200000	607.0	3	27	30	76.184	0.126
B1440000	693.4	5	32	37	82.185	0.119
B2000000	1079.9	6	51	57	94.221	0.087
<b>B2100000</b>	<b>1270.4</b>	<b>6</b>	<b>67</b>	<b>73</b>	<b>94.269</b>	0.074
B4050000	1686.6	9	262	271	146.441	0.087
B4080000	1691.6	10	262	272	146.685	0.087

Haw River near Bynum (ambient water quality monitoring station B2100000) is part of a special study on 1,4-dioxane in the Cape Fear River Basin. Half of the 50 samples tested for 1,4-dioxane between November 2017 and May 2023 were above the PQL of 1 µg/L with an instream mean and median concentration of 9.5 and 2.4 µg/L respectively and ranged between 1.2 and 65 µg/L.

Data from DWR and POTW special studies found that SIUs discharging to the City of Greensboro and Reidsville were the primary source of 1,4-dioxane to the Haw River subbasin and downstream into Jordan Lake. The City of Burlington was also identified as discharging 1,4-dioxane to this system.

The Haw River instream 1,4 dioxane concentrations at station B2100000 near Bynum, NC have decreased significantly since 2020 with a few spikes captured in 2021 (see chapter 13 for data figures and summary tables). These decreases coincide with the decreased discharge from the three major dischargers upstream (Greensboro, Reidsville and Burlington). Instream data at B2100000 is not available between June 2023 and February 2025. Monitoring has resumed as of March 2025 with results available on the 1,4-Dioxane Surface Water Sampling Results [dashboard](#).

Overall, the instream 1,4-dioxane data in the Haw River shows a major drop in the instream concentrations overtime. There were several periods where overlapping spikes occurred at the upstream B4 station and downstream B2100000 station showing the impact from Reidsville. There are other spikes detected at the Haw River downstream station (B2100000) that are contributed by other sources below Reidsville. Efforts to reduce 1,4-dioxane from POTWs to surface water supplies in the Haw River subbasin have been demonstrably successful. POTWs must remain committed to controlling this compound at the source by utilizing their pretreatment permitting authority to eliminate discharge of 1,4-dioxane to their treatment works in order to continue to protect all uses in this subbasin. More information on 1,4-dioxane and other emerging contaminants can be found in Chapter 2 (section 2.12) and chapters 12 (PFAS) and 13 (1,4-dioxane).



Benthic macroinvertebrate station BB443 at US 64 is the last site before the Haw River enters Jordan Lake Reservoir. This station is composed of multiple channels with good habitat including decent riparian buffers and stable banks. This location has been sampled since the early 1980s with the conditions remaining rather stable over this timeframe. The rating dropped from Excellent to Good between 2013 and 2018 mainly due to the loss of a single pollution-intolerant stonefly species [*Agnetina sp.* (Plecoptera: Perlidae)]. The biologists noted that siltation continues to be a problem in the Haw River and the elevated pH (8.4 s.u. on June 25, 2018) at this station may suggest increased photosynthesis by large quantities of algae and could indicate elevated nutrient levels in the river. This assumption is supported by instream water quality data both upstream and downstream of this benthic station.

BB443	
Year*	Bioclassification
1984	Good-Fair
1990*	Good
1998	Good
2002	Good
2008	Excellent
2013	Excellent
2018	Good
* Special Study	

The Haw River arm of Jordan Lake [AU# 16-(37.5)a1; WS-IV; B; NSW; CA; (694.45 freshwater acres)] from approximately 1.0 miles below US Hwy 64 to downstream of Stinking Creek Arm captures drainage from Robeson and Stinking creeks and is assessed using lakes monitoring data collected at the station CFPO55C. (Figure 6-85).

The Haw River arm of Jordan Lake [AU# 16-(37.5)a2; WS-IV; B; NSW; CA; (651.54 freshwater acres)] from downstream of Stinking Creek Arm to the dam at B. Everett Jordan Lake is assessed using two lake stations, CPF055D and CPF055E. DWR's Water Sciences Section (WSS), Intensive Survey Branch (ISB), monitors Jordan Lake on a regular schedule and their Jordan Lake annual

monitoring reports and study plans are available on their website ([Falls and Jordan Lakes Monitoring webpage](#)).

The entire Haw River arm of Jordan Lake is exceeding criteria and listed as impaired on the 2022 IR for chlorophyll *a*, high pH (>9) and turbidity concentrations (*Table 6-24* and *Table 6-52*). The percent exceedance of the chlorophyll *a* standard for the three stations ranged from 17.5 to 31.6 % of the time between 2016-2020 (*Table 6-52*). There is an EPA-approved TMDL for nitrogen, phosphorus and total suspended solids. The entire Haw River watershed draining to Jordan Lake is required to reduce loading to Jordan Lake in order to comply with the TMDL and Jordan Lake NSW rules. The goal of the TMDL and the strategy is to improve the water quality conditions in Jordan Lake. The reductions needed to improve conditions in Jordan Lake will also result in improved local water quality conditions. See Section 0.8 and *6.6.6.9* for more details regarding the Jordan Lake water quality conditions, NSW strategy and TMDL. *Jordan Lake water supply nutrient strategy rules readoption and implementation is critical in order to improve the water quality conditions in the Haw River arm of Jordan Lake.*

A 4.3-mile segment of the mainstem Haw River [[AU# 16-(42); WS-IV; from dam at B. Everett Jordan Lake to Cape Fear River] flows south out of the dam at Jordan Lake and meets with the confluence of the Deep River to form the Cape Fear River in HUC 03030004 (Upper Cape Fear River). There are two ambient monitoring stations (B4050000 and B4080000), two major industrial discharge permits (as-build <400,000 gpd), and a minor domestic and a single-family discharge permit in this section of the Haw River.



Station B4050000 is located just downstream of the Jordan Lake dam release and captures the physical and chemical water quality conditions leaving Jordan Lake. Nutrients and chlorophyll *a* were collected at this station only in 2019 and 2020 as part of a Central Cape Fear River modeling plan (See Chapter 2.13) for more details.

This station is also part of the special study on 1,4-dioxane in the Cape Fear River Basin. Of the 37 samples tested for 1,4-dioxane between February 2018 and May 2023, 19 readings were above the PQL of 1 µg/L with an instream mean and median concentration of 3.6 and 2.3 µg/L respectively and ranged between 1.0 and 12 µg/L. More information on 1,4-dioxane and other emerging contaminants can be found in Chapter 2 (section 2.12) and chapters 12 (PFAS) and 13 (1,4-dioxane).

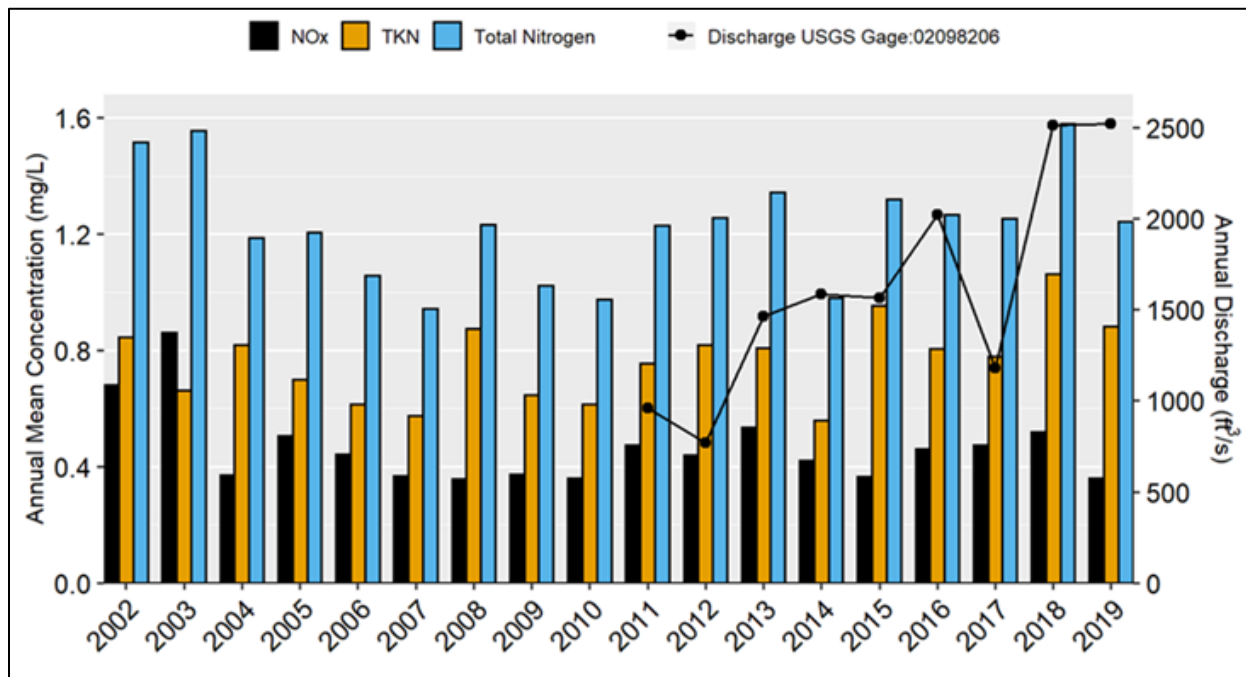
Station B4080000 at Old US 1 is about 1.5 miles upstream of the confluence with the Deep River capturing the water quality of the Haw River prior to becoming the Cape Fear River.

The instream nutrient concentrations vary, with TN, NO<sub>x</sub> and TP concentrations generally lower downstream of Jordan Lake, TKN concentrations similar to upstream, and ammonia concentrations higher at station B4050000 (*Table 6-27*). The increase in ammonia could be the result of ammonia released during decomposition processes and recycling of nutrients in the deeper sections of Jordan Lake near the dam and transported downstream through the dam gates. The concentrations of ammonia are highest at low

flows indicating that at high flows, ammonia is likely diluted somewhat which is different than most of the other stations throughout the Haw River watershed (Figure 6-17). The elevated ammonia concentrations decline at the downstream station B4080000 with the five-year annual mean of 0.10 compared to 0.18 mg/L respectively (Table 6-27). Further investigation into a possible local source of ammonia at B4050000 is needed.

TKN is the highest component of TN below the dam (Figure 6-117). This is likely due to the NOx being utilized upstream in the lake. Algal productivity was relatively high for a flowing stream (sampled in 2019 and 2020 only) with a mean chlorophyll *a* concentration of 15.8 µg/L and readings ranging between 4.2 and 34 µg/L (n=23 records; Figure 6-118). This was the case even with elevated turbidity levels (Figure 6-118). It is unclear as to how biologically productive this segment of the Haw River is. The chlorophyll *a* recorded at station B4050000 located directly downstream of the dam at Jordan Lake could potentially have been transported downstream from the lake like much of the nutrients and sediment. The lake appears to work as a sediment and nutrient trap. Chlorophyll *a* data is not available at station B4080000 to know if these concentrations remain elevated throughout the lower Haw River. Perhaps a special study understanding the algal productivity in this section of the Haw River would be helpful in understanding impacts to the Cape Fear River, which is impaired behind Buckhorn Dam (Buckhorn Dam is ~6 miles downstream of the confluence of the Cape Fear River). Understanding the chlorophyll *a* concentrations in the lower Haw and Deep rivers may be critical to developing appropriate criteria in flowing streams as directed by EPA and as part of the NC Nutrient Criteria Development Plan (NCDP, See Chapter 2.13).

Figure 6-117: Haw River Ambient Monitoring Station B4080000 (near Haywood, NC) Annual Mean Nitrogen Constituent (NOx, TKN, TN) Concentrations Between 2004 and 2019.



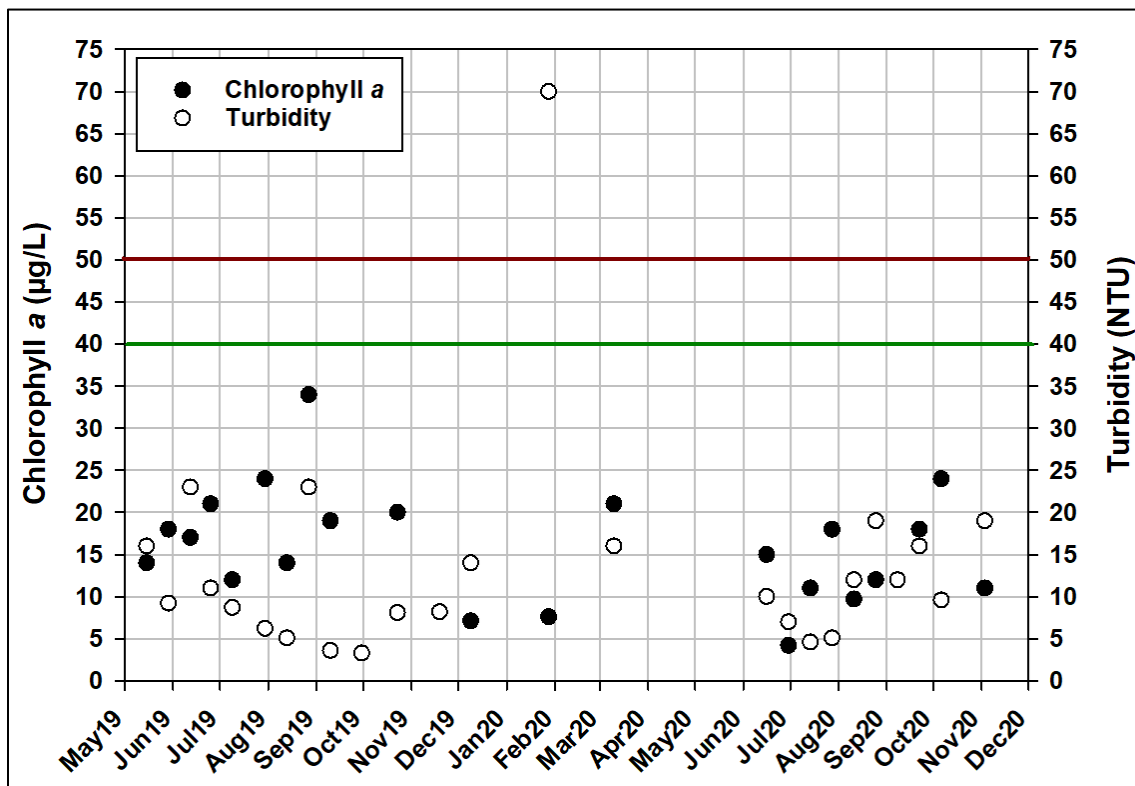
Flow at USGS Gage Station 02098206 (Moncure, NC) Superimposed for Annual Streamflow Comparison.

The instream turbidity concentrations are fairly consistent between the two stations (*Figure 6-119* and *Table 6-27*). As with the stations upstream of Jordan Lake, concentrations are higher during high-flow periods due to contributions from stormwater runoff but are generally lower at B4050000 and B4080000 as Jordan Lake captures some of the sediment from the watershed above during these high-flow events. The concentrations at the low- and mid-level flows are similar to the concentrations seen in the mainstem Haw River above Jordan Lake (*Figure 6-17*).

DWR conducted a seasonal and non-seasonal Mann-Kendall trend test at station B4080000 and found a significant nonseasonal decreasing trend in total phosphorus and an increase trend in TKN as well as a significant seasonal increase in turbidity for data collected from 2010-2019 (calculated at 95% confidence) (*Table 6-27*).

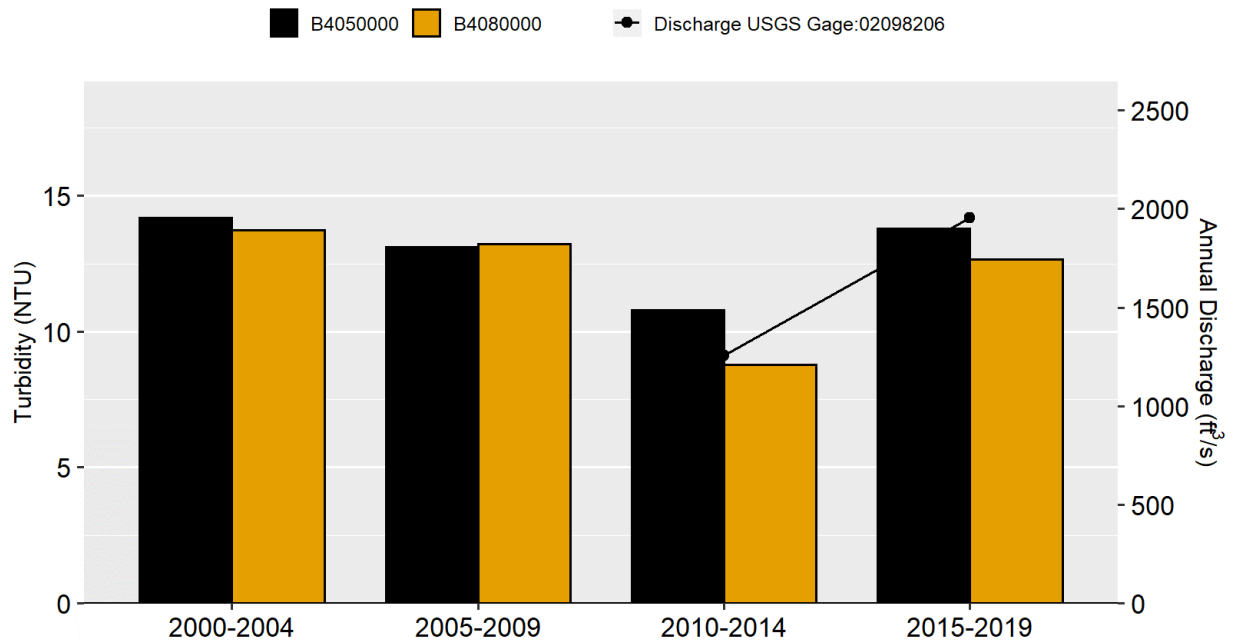
This lower section of HUC 0303000207 below Jordan Lake is well buffered with minimal access and development occurring. The water quality conditions are likely heavily impacted by the conditions in Jordan Lake and the few industrial uses downstream of the lake.

*Figure 6-118: Lower Haw River AMS Station B4050000 Chlorophyll a and Corresponding Turbidity Concentrations (May 2019 - November 2020).*



Note: Green Line Represents Chlorophyll a Standard and Red Line Represents Turbidity Standard in C and WS-IV Classified Streams).

Figure 6-119: Five-Year Average Turbidity on the Mainstem Haw River Below Jordan Lake in HUC 0303000207 with Stream Flow at Haw River Near Moncure, USGS Gage Station 02098206.



#### 6.6.7.5 Robeson Creek – Haw River Watershed Summary

This subwatershed is unique in that the Haw River mainstem flows from just above the confluence with Dry Creek and becomes the Haw River arm of Jordan Lake, then emerges from the Jordan Lake dam to flow about 4.3 miles where it becomes the Cape Fear River at the confluence with the Deep River.

Currently (2022 IR) the only section of the Haw River in the Robeson Creek subwatershed that is formally listed as impaired is the Haw River arm of Jordan Lake [AU# 16-(37.5)a1 and 16-(37.5)a2] (Table 6-24). This impairment is based on exceedances of the Chlorophyll *a*, pH, and turbidity lake standards. Due to the decreased flow through this section, the elevated nutrients result in high biological productivity which lead to excursions of the chlorophyll *a* and pH instream standards (Table 6-52, stations CPF0055C, CPF0055D and CPF0055E). The chlorophyll *a* excursions ranged between 17.5 and 31.6% and the pH between 13.6 and 18.3% during the 2022 IR assessment period of 2016-2020 (Table 6-52). Biological productivity also impacts the turbidity concentrations; however, sedimentation from upstream sources is likely the significant contributor of the turbidity impairment in the Haw River arm of Jordan Lake. Elevated turbidity generally reduces algal productivity by blocking the sunlight needed for algae to grow.

The remaining portions of the Haw River have elevated nutrients well above those concentrations found in the headwaters prior to the influence of wastewater discharges to the system (Table 6-27). There is also a source of ammonia seen at the station (B4050000) just downstream of Jordan Lake dam that needs to be investigated. Fecal coliform bacteria and turbidity remain elevated throughout the mainstem Haw River flowing to Jordan Lake. There are several TMDLs upstream that identified many sources. Implementation measures identified to reduce loading of bacteria and sedimentation should be applied

throughout the Robeson Creek–Haw River watershed (0303000207) and in the watersheds draining to it. Implementation of Jordan Lake Nutrient Management Rules is critical to reduce nutrient loading from all sources in the watershed.

There are two watershed action plans and two TMDLs that need to be implemented in this watershed. The Dry Creek Watershed Action Plan was completed in 2022 and should be utilized to coordinate and guide watershed activities in order to restore and protect the watershed to support a healthy aquatic ecosystem and biological communities (section 6.6.7.1). DWR biologists recommended station BB307 remain on the basin monitoring schedule to assess water quality improvements as the watershed plan is implemented over time. Implementation of the Jordan Lake rules and BMPs to reduce sediment loading to Dry Creek is also recommended.

The Jordan Lake watershed TMDL requires reduction of nutrients (N and P) to all of the Haw River watershed including Robeson Creek which also has a 2004 total phosphorus TMDL that requires a reduction in total phosphorus load specific to the needs of this smaller subwatershed. A 2013 Robeson Creek Watershed Restoration Plan was also developed to plan and work towards healthy functioning streams and water bodies while providing sustainable recreational and economic opportunities for its users. The implementation of this plan is not currently a priority. It is recommended that the Town of Pittsboro work to identify a watershed champion to facilitate and engage with watershed stakeholders to implement the watershed restoration plan (Section 6.6.7.3).

Efforts to reduce phosphorus from the wastewater treatment facility occurred and the chicken processing plant closed and ceased applying waste to fields that were identified as impacting instream phosphorus concentrations as well as impacting the aquatic life. The TMDL also identified fertilizer applications as a source of phosphorus to Robeson Creek. Education of the local citizens and homeowners is needed so over-application of nitrogen and phosphorus fertilizers are reduced.

This watershed has experienced rapid development that is continuing with the 7,068-acre Chatham Park development project. Given that Chatham Park drains to both Robeson Creek and the Haw River, both of which suffer from nutrient over-enrichment impairments, and that nonpoint source runoff is a major contributor, it is important that Chatham Park make all efforts to reduce its hydrologic and nutrient inputs to waterways. Several recommendations are included to address stormwater runoff from new development that the current (2023) stormwater rules do not address. Many of these are needed to protect the important drinking water resources as well as limit aquatic habitat and recreation impacts. See section 6.6.7.3 for more details. The recommendations include encouraging Pittsboro and Chatham County to strengthen stormwater ordinances beyond state minimums to achieve meaningful runoff reduction and nutrient control from all new development. This would include lowering development density at which stormwater treatment is required to below 10% BUA, encouraging runoff volume matching where possible, requiring some level of runoff reduction beyond the default treat-and-release standard and requiring tracking and reporting by Chatham Park of actual development post-construction control outcomes to verify that the Park’s “exceptional development” point system adequately addresses stormwater needs or provides a basis for revising it appropriately.

Limitations of current stormwater control requirements need to be addressed. State stormwater rules are a good start as a minimum but do not provide for sufficient volume control or water quality treatment from large storm events or reduce nutrients to address the overall nutrient reduction measures needed in the Robeson Creek and Jordan Lake watersheds.

To better protect receiving streams in growing areas of the basin, communities are encouraged to consider strengthening post-construction stormwater control requirements beyond state minimums. Examples include treating larger storm events, requiring infiltration volume, threshold treatment for less than 24% BUA, requiring runoff volume match and peak flow mitigation among many other opportunities. The goal is to reduce the effects of runoff to sensitive receiving streams due to increased impervious surfaces and/or changes in the watershed.

DWR encourages community leaders and developers to maximize the use of low-impact development (LID) designs and distribute stormwater control measures throughout the community in such a way that it reduces runoff to a volume that matches pre-development conditions. Maximizing the use of nutrient reducing stormwater controls will also decrease the amount of nitrogen and phosphorus leaving the site and impacting already over-enriched systems.

## 6.7 Haw River Subbasin Water Use

Water resources in the Cape Fear River Basin include surface and groundwater, as well as water moving through built infrastructure. North Carolina has a diverse array of water users throughout the state, including public and private water supply systems that supply drinking water to their customer base, industries such as food production, wood manufacturing and metal processing; and energy production (hydroelectric and thermoelectric). Water is also used statewide for agricultural, mining and recreational purposes. The availability and continued use of water by all users is vital to the continued prosperity of the communities and ecosystems of this state.

There are several programs within DEQ that provide information about how much water is being used in North Carolina. These include the Water Withdrawal and Transfer Registration (WWATR) Program, the Local Water Supply Planning (LWSP) Program, the Central Coastal Plain Capacity Use Area (CCPCUA) and the Interbasin Transfer (IBT) Certification Program. Several programs are also in place to protect drinking water sources including the Source Water Assessment Program (SWAP), the Surface Water Protection Program (SWPP) and the Wellhead Protection Program (WHP). Additionally, the Groundwater Resources Branch (GWRB) oversees the assessment, monitoring, and management of the state's groundwater resources. More information about these programs can be found in Chapter 3 and Chapter 5.

In addition to administering programs for water use and protection, DEQ plays a critical role in providing technical and managerial support for the development and use of surface and groundwater resources and calculating the volume of water moving through a system. For agriculture water use, the North Carolina Department of Agriculture & Consumer Services (NCDA&CS) plays a critical role in collecting statewide water use data. Information included in this section is taken from the Water Quantity Assessment and Planning in the Cape Fear River Basin, Chapter 5.

### 6.7.1 Water Use and Availability Reported in Local Water Supply Plans

The information presented in this section quantifies water demand/use and available water supply on a subbasin scale based on public water supply systems that submitted local water supply plans in the Deep River subbasin. Per North Carolina General Statutes §143-355(l), the Local Water Supply Planning Program applies to units of local governments and community water systems that regularly serve 3,000 or more individuals or have 1,000 or more service connections. See Chapter 5 for more information on water use and availability along with data qualifications and methodologies.

Twenty-one water systems are included in the Haw River subbasin. Based on the information reported by users, not including ecological flow, domestic users, non-reporters and other unknown usages; there are no apparent water supply issues in the Haw River subbasin. Based on 2020 data, the Haw River subbasin has the greatest demand of any subbasin within the larger Cape Fear River basin. The 2020 Haw River subbasin population served by public water supply systems was 825,481. The public water supply systems in this subbasin had a combined average daily water demand of 81.3 MGD in comparing this to the total available supply reported by these 21 public water supply systems in 2020 of 179.6 MGD, the combined average daily demand of the public water supply systems in the Haw River subbasin was about 45% of available supply. The City of Greensboro is the largest system in the subbasin with an average daily water demand in 2020 of 32.9 MGD, or approximately 40% of the combined subbasin demand. A detailed

description of the public water supply availability, demand and projections for the Haw River subbasin is in Chapter 5.

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*In 2021, an interlocal agreement was reached between the City of Sanford and Pittsboro, Chatham County, Holly Springs, and Fuquay-Varina to study, design, and complete construction of an additional 18-million gallon per day water treatment facility upgrade in Sanford to meet the water supply needs of all five partners. Of these, only the Town of Pittsboro and parts of Chatham County are located within the Haw River watershed. The 18 MGD upgrade will increase the current treatment capacity from 12 MGD to 30 MGD when complete. The expansion of water plant was started on October 29, 2024, with an anticipated completion in 2028. In March 2024, the City of Sanford announced it was intending to provide regional water utilities to surrounding towns and counties under the name TriRiver Water (<https://www.tririverwater.com/>). This information will be included in future local water supply plans.*

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#### 6.7.2 Interbasin Transfer Certificates

The North Carolina Legislature adopted the Regulation of Surface Water Transfers Act (NCGS §143-215.22L) in 1993. The intent of the law is to regulate large surface water transfers between river basins by requiring a certificate from the Environmental Management Commission (EMC). [NCGS §143-215.22G](#) established 38 interbasin transfer (IBT) basins. An IBT certificate is required for a transfer greater than 2.0 million gallons per day (MGD) between any of the defined IBT river basins. In the Haw River (2-1) basin, which overlaps reasonably well with the Haw River subbasin (03030002), there is one IBT Certificate for Wake County (Cary, Apex, and Morrisville) to transfer from the Haw River (2-1) “source” basin to Neuse River (10-1) and Cape Fear River (2-3) “receiving” IBT basins. This IBT Certificate was issued in 2015 with maximum allowable amounts of 31 MGD to the Neuse River (10-1) and 2 MGD to the Cape Fear River (2-3). Based on the information reported in 2020, the annual average IBT basin transfer from the Haw River (2-1) was 15.9 MGD to the Neuse River (10-1) and 0.09 MGD to the Cape Fear River (2-3). More information about IBT Certificates in the Cape Fear River basin can be found in Chapter 5.

#### 6.7.3 Jordan Lake Round 4 Allocation

The water supply storage pool of B. Everett Jordan Reservoir was designed to reliably provide 100 million gallons per day of water supply. The NC General Assembly delegated authority to allocate water supply to the Environmental Management Commission (EMC). Allocations are made as a percentage of the water supply pool to address documented needs for 30 years into the future. The EMC is mandated by rule to limit allocations that would result in a diversion of water off the Jordan Lake watershed to 50% of the water supply pool (NC DEQ-DWR, 2016).

In 2016 the EMC approved the fourth round of water supply allocation for Jordan Lake. During the decision-making process, the Division of Water Resources produced two reports: [Cape Fear River Surface Water Supply Evaluation \(CFRSWSE\)](#) and [Jordan Lake Water Supply Allocation Recommendations \(JLWSAR\)](#). Both reports used the OASIS hydrologic river basin modeling to simulate the routing of water

in the Cape Fear River Basin above William O' Huske Lock and Dam 3. These reports represent the most recent DEQ-DWR effort to update and run the Cape Fear – Neuse River Combined OASIS model to determine if there is likely to be sufficient quantities of water available at specific water supply intakes to cover the expected withdrawals needed to meet specific water demand levels, whenever they occur. The CFRSWSE analysis was limited to public water systems and other self-supplied industrial facilities that use surface water and the neighboring water systems that depend on them. The JLWSAR analysis focused on the information relevant to the decisions concerning the allocation of water supply storage from Jordan Lake (NCDEQ, 2016). These two documents are available through the North Carolina Department of Environmental Quality website ([Round 4 | NC DEQ](#)). *Table 6-61* shows the Jordan Lake round-4 applicant allocations which total 95.9% of the water supply pool in Jordan Lake. The City of Raleigh rescinded their 4.7% allocation in 2019, making the final round-4 allocation total 91.2% of the water supply pool. The Jordan Lake round-4 allocation information is located in Chapter 5, section 5.14.4.1.

Table 6-61 Jordan Lake Water Supply Round-4 Allocation Requests and Awards.

Allocation of Jordan Lake Water Supply Pool		
Applicant	Jordan Lake Round 4 Requested Allocation	Jordan Lake Round 4 Approved Allocation
	Allocation Percent	Allocation Percent
Cary Apex Morrisville RTP	46.2	46.2
Chatham County - North*	13	13
Durham*	16.5	16.5
Fayetteville PWC	10	0
Hillsborough	1	1
Holly Springs	2	2
Orange County	1.5	1.5
Orange Water and Sewer Authority*	5	5
Pittsboro*	6	6
Raleigh <sup>+</sup>	4.7	4.7
<b>Total</b>	105.9	<b>95.9</b>

\*Western Intake Partner

+Rescinded EMC-approved allocation percentage as of 2019 (City of Raleigh, 2019 - [link](#))

#### 6.7.4 Western Intake Partnership

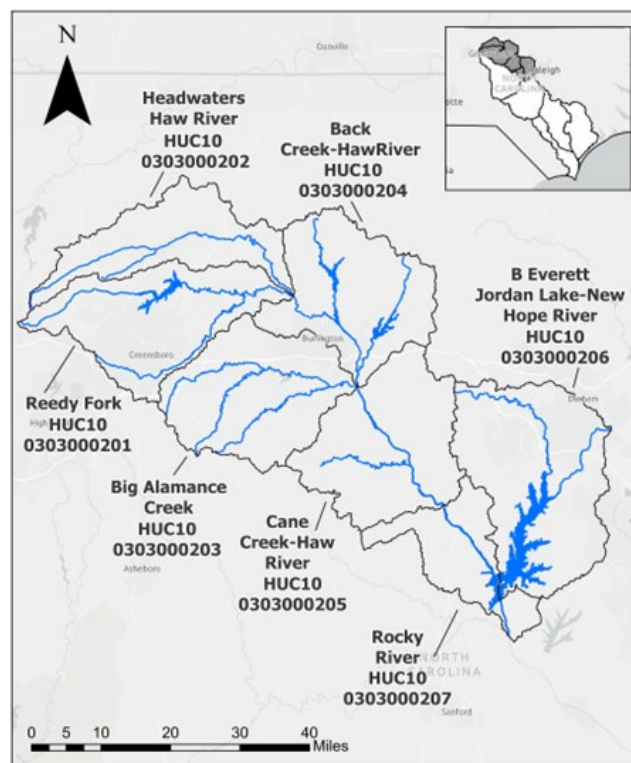
The Town of Pittsboro, Chatham County, the City of Durham, and the Orange Water and Sewer Authority partnered together to form the Western Intake Partnership (WIP). The WIP has been working together on a proposal to construct a new intake and water treatment plant on the western side of Jordan Lake. The Jordan Lake Round 4 allocation provided a guaranteed source of water enabling potential success with this cooperative project. The new facilities would allow these systems to access their Jordan Lake allocations and provide the ability to fully utilize the water supply storage in Jordan Lake reservoir. Development of a new intake, treatment plant and transmission pipelines face an extensive review and approval process. The new facility is expected to be operational by 2035. With the 80 million gallon per day limit on the existing raw water intake an additional intake will be required if the state is to reap the maximum benefits of the water supply storage in Jordan Lake reservoir. As currently envisioned the project would include a new raw water intake and pump station in or adjacent to the reservoir, a treatment plant constructed on land owned by the Orange Water and Sewer Authority adjacent to the US Army Corps of Engineers' property and finished water pumping and transmission facilities to deliver water to the project partners.

## 6.8 Protecting Water Resources in the Haw River Subbasin

### 6.8.1 Haw River Subbasin Summary

The Haw River subbasin (HUC-8) watershed covers 1,707.6 square miles and is subdivided into seven HUC-10 watersheds. The Haw River and New Hope River come together to form B. Everett Jordan Lake, the largest freshwater reservoir in the Cape Fear River Basin. Jordan Lake is a multi-use impoundment built in 1983 and operated by the US Army Corps of Engineers. A 4.3-mile segment of the Haw River flows south out of the dam and meets the confluence of the Deep River to form the Cape Fear River in the Upper Cape Fear River subbasin, HUC 03030004.

More than 43% of the Cape Fear River basin residents reside in the Haw River subbasin. Based on the 2020 US Census data, the Haw River subbasin is home to over one million people (1,000,759). This number grew by 15%, with the addition of more than 154,000 people during the last 10-year census period (*Table 6-4*). More than half (84,503) of the population growth from 2010 to 2020 occurred in the Jordan Lake-New Hope Creek subwatershed that includes parts of Durham, Orange, Wake and Chatham counties. The most-populated municipalities in the Haw River subbasin are Greensboro and Durham (Section 6.1.1, *Table 6-4*).



The 2019 (NLCD) land cover was primarily dominated by forest (47%), development (24%), and agriculture (20%) (*Figure 6-6* and *Table 6-5*). Developed land increased by 57 square miles over the 18-year (2001-2019) time period, due to the conversion of agriculture and forested lands. Sections of the Haw River subbasin are highly urbanized with two of the seven subwatersheds having more than 30% developed land use identified (Reedy Fork at 47% and Jordan Lake-New Hope River at 34%; *Table 6-6*).

Due to water quality concerns, the EMC declared Jordan Lake as nutrient sensitive waters (NSW) the same year it was impounded. A nutrient response model was completed and accepted by the Water Quality Committee of the EMC in July 2002. The nutrient response model predicted a high frequency of violations of the chlorophyll *a* standard in the Upper New Hope arm segment of the lake. As a result of this model prediction, the Upper New Hope arm of Jordan Lake was placed on the 2002 NC 303(d) list of impaired waters. The Lower New Hope arm and the Haw River arm were later placed on the impaired waters list in 2006 for chlorophyll *a* impairment.

A TMDL for Jordan Lake was approved by the US Environmental Protection Agency in September 2007. The objective of a TMDL was to estimate the allowable pollutant loads and allocate the loads to known sources so that the waterbody may be restored to its intended uses. Through the combined efforts of many watershed stakeholders and DWQ, multiple modeling tools were developed to evaluate conditions in the reservoir and determine potential management strategies. A Jordan Lake Nutrient Management

Strategy was developed based on reductions in both total nitrogen and total phosphorus from point and nonpoint sources. Portions of the strategy went into effect in August 2009 and others have been delayed (see section 6.6.6.9 for details).

The NC legislature created the NC Policy Collaboratory to study and re-model Jordan Lake and the watershed in order to provide additional scientifically based information to inform and direct the Jordan Lake watershed rules readoption process which is scheduled to begin in late 2023/early 2024.

The Jordan Lake Nutrient Management Strategy which is intended to address nutrients (N and P) covers the entire watershed above Jordan Lake Dam which consists of two distinct river arms and three distinct management areas, the Haw River Arm and the Upper and Lower New Hope Creek arms (*Figure 6-85* and *Figure 6-110*).

The Haw River subbasin accounts for more than one-third (146.73 MGD) of the total permitted as-built discharge (425.47 MGD) in the Cape Fear River basin. There are 11 major permitted NPDES municipal and industrial WWTPs and 54 minor NPDES wastewater (excluding single-family) permits in the subbasin (*Table 6-9*). These wastewater systems are required to meet a total nitrogen and total phosphorus discharge allocation as part of the Jordan Lake Nutrient Management Strategy. This has resulted in a significant decline in the nitrogen and phosphorus load from point sources to Jordan Lake over the last several years. Several wastewater treatment facilities are currently in discussion with DWR about expanding their facilities to accommodate future growth. The NC Collaboratory reported that point sources are the largest total nitrogen contributor (50%) and second largest total phosphorus contributor (25%). They also found that leakage from sanitary sewer collection systems contribute to nutrient loading as well. *Efforts need to be made to reduce infiltration and exfiltration in the sanitary sewer collection systems throughout the Haw River subbasin.*

NPDES minor wastewater package plants have been identified as potential sources of nutrients and bacteria across the state. Most of these systems discharge to small creeks and streams, and their impacts are not well documented due to limited instream data. Where data is available, impacts to aquatic ecosystem health has been documented by field biologists. Instream ambient data indicate these small systems can have negative water quality impacts locally and cumulatively especially in nutrient sensitive watersheds and in systems that drain to lakes and estuaries where nutrients result in eutrophic conditions.

Operation and maintenance (O&M) varies depending on the type of system. NPDES inspectors have indicated that many of these plants are in poor condition which makes them more vulnerable to violations causing water quality issues. Regional Office inspectors feel that more time spent on site would be beneficial, improving system operation and compliance. These systems are privately owned and get little attention and funding compared to municipal plants.

*During the Jordan Lake rules readoption process, DWR should consider reviewing the current operational requirements for these minor facilities to identify where opportunities may exist to improve O&M and monitoring of effluent and instream water quality.* Basin planners have identified several systems throughout the basin that may be having an impact on surface water quality and aquatic habitat. These systems could potentially benefit from a review of their O&M to determine if upgrades are needed and

collecting data from their effluent and instream could help determine if they are truly impacting water quality.

There are 209 NPDES single-family domestic wastewater discharge and 222 non-discharge single-family residence wastewater irrigation minor NPDES permits in the Haw River subbasin near Jordan Lake in Chatham, Durham and Orange counties where the Triassic Basin Level IV and Carolina Slate Belt ecoregions are located. There is a need for homeowner education on how to properly maintain and operate single-family wastewater treatment systems to reduce their impact on water quality. Connecting single-family NPDES waste management system to regional wastewater facilities would likely improve water quality as many of these systems are not well maintained and are known to contribute nutrient and bacterial loading to local streams and Jordan Lake. Single-family wastewater treatment systems which discharge less than 1,000 gallons per day of (100%) domestic waste fall under a NC NPDES general permit number NCG550000. For NCG550000 permit as well as operation and maintenance information see the October 2020 [DEQ technical bulletin](#) and the [NPDES general permits website](#).

Half (16) of the 32 NPDES MS4 stormwater permits in the Cape Fear are located in the Haw River subbasin. Stormwater runoff has been identified throughout the watershed as a major contributor of sediment/turbidity, bacteria and nutrient loading. There is a need to improve stormwater management measures throughout the Haw River watershed and must include management measures on new and existing development. The delayed implementation of the Jordan Lake stormwater management rules has only resulted in a greater need for more substantial overall nutrient load reductions for Jordan Lake to meet water quality standards to protect the designated uses as described by the Clean Water Act. The geology in certain parts of this watershed also make managing stormwater more challenging and the use of appropriate best management practices in these areas is critical. There is also a challenge with the changing climate, resulting in more frequent large storm events and the potential need to resize BMPs to capture these storm events to reduce runoff, peak stream volume and velocities. High flows and stream velocities are resulting in more stream bank erosion, increasing the contribution of sediments and legacy nutrients to the system. The NC Collaboratory found that large storms or high flow events carry a significant fraction of the annual nutrient loads to Jordan Lake.

Fewer permitted AFOs are located in the Haw River subbasin compared to subbasins located in the lower part of the Cape Fear River basin. Permitted AFO facilities include 12 cattle, four swine and seven individual state permits ([Table 6-9](#)). Poultry operations are deemed permitted under current rules and statutes and very little is known about where the poultry waste is land applied, how it is managed, or its potential impacts on water quality. The poultry industry is believed to be growing in this region as there is a new (2019) poultry processing plant in Siler City. There is anecdotal evidence that this industry is growing throughout the western portion of the Haw River watershed near the processing plant. Biologists have also noted an increase in organic material in the streams. When resources allow, additional monitoring or a special study should be conducted to identify organic sources in the watershed and what impact they may be having on water quality. Overall, the agricultural community has reduced their nutrient loading as required by the Jordan Lake Nutrient Management Strategy. The NC Policy Collaboratory indicated that the agricultural community's largest nutrient load contribution is from grazed pastures with stream access which can be improved with livestock exclusion fencing and buffers. This effort would need to come with support from cost-share funding as the effort would also include adding

water supply wells and watering stations to farms. These practices can be costly but are known to improve animal health as well as improve local and downstream water quality. The Collaboratory *also recommended buffering agriculture-adjacent streams and utilizing soil test P levels to prevent phosphorus from being overapplied.*

Many of the current ambient stations are associated with waterbody locations where known pollution sources occur from land use activities in the subbasin. There are also portions of the subbasin where no water quality data are collected; therefore, water quality in those areas cannot be evaluated.

The Haw River subbasin has more impairments listed on the 2022 IR than any other subbasin in the Cape Fear River basin, accounting for close to half (47.9%) of the impaired freshwater (FW) miles (309) and over 90% of the FW acres (11,376) (*Table 6-1*). The impairments are associated with both urban and rural areas. Most of the impaired FW acres have a TMDL or management strategy and 5% of FW miles have a TMDL (*Table 6-12*). In addition to TMDLs in the Haw, there is one EPA approved 4b-demonstration plan for the Little Alamance Creek and eight 9-element watershed action plans developed to assist in prioritizing watershed actions to address water quality impairments leading to improved water quality and removal from the 303(d) impaired waters list (*Table 6-13*).

Impairments to rivers, creeks and streams were most frequently attributed to benthos communities and the most common impairment to FW acres was due to chlorophyll *a*, accounting for 222.6 FW miles and 11,460.5 FW acres, respectively. (*Table 6-2*). Total nitrogen and total phosphorus were identified as the causal parameters resulting in the chlorophyll *a* response and impairment. All three management arms of Jordan Lake are impaired (2022 IR) due to chlorophyll *a* standard violations (*Figure 6-111* and *Figure 6-112*). Parts of the Upper New Hope Creek Arm and Haw River Arm are also impaired due to turbidity and high pH standard violations. Jordan Lake has been consistently classified as eutrophic or hypereutrophic as result of excess nutrient inputs and resulting algal production.

Other common impairments include 70.8 FW miles for fish community, 45.9 FW miles for metals [dissolved copper (5.6 miles), total copper (25.7 miles), total zinc (14.6miles)], 56.1 FW miles for fecal coliform, 3,752.1 FW acres for turbidity and 2,761.9 FW acres for pH (*Table 6-2*).

The Haw River subbasin in comparison to the other five Cape Fear River subbasins had the highest five-year (2016-2020) mean for turbidity, TSS, TN and inorganic nitrogen, nitrite-nitrate (NO<sub>x</sub>) (Chapter 2, Table 2-9). At the HUC-10 scale within the Haw River subbasin, the B. Everett Jordan Lake-New Hope watershed (0303000206) had the highest five-year mean concentrations for conductivity, turbidity and TSS levels (*Table 6-10*). Reedy Fork watershed (0303000201) had the highest mean ammonia, NO<sub>x</sub>, TN and TP levels while the Cane Creek-Haw watershed (0303000205) had the highest TKN levels and Big Alamance Creek (0303000203) had the highest fecal coliform bacteria levels in the Haw River subbasin. The Reedy Fork watershed (HUC-10 scale) had the second highest mean levels for NO<sub>x</sub> (2.53 mg/L) and TN (3.35 mg/L) in the entire Cape Fear River basin, behind the Rocky River watershed (0303000305) in the Deep River subbasin (*Table 6-10*). The main nutrient contributor in the Reedy Fork watershed is the City of Greensboro's 56 MGD T.Z. Osborne wastewater treatment plant which discharges to South Buffalo Creek. The treatment plant recently completed a system upgrade which should significantly reduce their total nitrogen effluent concentration and load to the system (section 6.6.1).

The NC Collaboratory also reported on a BMP cost effectiveness study for the Jordan Lake watershed and suggested that *wastewater treatment plant improvements, riparian buffers, and illicit discharge detection and elimination (IDDE) are the lowest cost strategies per pound nutrients removed. DWR will utilize the Collaboratory's findings to help guide the development of revised Jordan Lake Nutrient Management Strategy rules.*

### 6.8.2 Haw River Subbasin Recommendations

The Basin Planning Branch (BPB) continually works with the Nonpoint Source Planning Branch, Soil and Water Conservation Districts (SWCD), Natural Resources Conservation Service (NRCS) and various stakeholders throughout the region to improve our understanding of point and nonpoint sources of pollution and encourage continued efforts to implement best management practices (BMPs) and restoration activities that reduce nutrients, bacteria, sediment loads and stormwater flow volume to the receiving waterbodies.

Recommendations and actions to improve and protect water quality are listed in detail throughout the Haw River subbasin chapter. Some of the key recommendations include:

- *DWR is implementing a collaborative public involvement process to rethink and revise the nutrient management strategy for the Jordan Lake watershed.* The NC Policy Collaboratory's Jordan Lake scientific study findings will be utilized to help inform and guide the nutrient management rules to address actions needed in the watershed to improve water quality and restore designated uses.
- Given the worsening impairment of Jordan Lake, the impairment of a large number of streams within the Haw watershed and the population growth occurring and anticipated in the Triad and Triangle, *better stormwater control is needed in growth areas.* Better protection of streams against increased runoff flows is recommended through enhancement of post-construction stormwater control by local programs to require a specified portion of the water quality runoff volume generated by new development to be eliminated through infiltration or evaporation/evapotranspiration. Another step would be to lower the density thresholds at which post-construction stormwater treatment is required. In the specific case of the 7,000-acre Chatham Park development, an additional step would be to require tracking and reporting of actual development post-construction control outcomes to verify that the Park's flexible "exceptional development" point system adequately addresses the stormwater component. See Section 6.6.7.3 for more detailed recommendations.
- *Limitations of current stormwater control requirements need to be addressed.* State stormwater rules are a good start as a minimum but do not provide for sufficient volume control or water quality treatment from large storm events or reduce nutrients to address the overall nutrient reduction measures needed in the Robeson Creek and Jordan Lake watersheds.
- There are several fecal coliform bacteria and sediment/turbidity TMDLs throughout the Haw River watershed. Both dry and wet weather sources were identified. The concentrations of these pollutants above and below the stream reaches with official TMDLs are also elevated. *The need*

to implement stormwater controls, implement animal waste collection programs (livestock and domestic), and improve municipal collection systems as well as septic systems will not only reduce nutrients as required by the Jordan Lake TMDL but will also reduce loading of bacteria and sediment to improve local water quality conditions that are needed throughout the entire watershed.

- Expand existing data collection (including source identification) to include agricultural watersheds with high concentrations of deemed permitted animal operations. DWR has little to no information on deemed permitted facilities making it difficult to determine if they are having an impact on water quality. Data could also be used by multiple local, state, and federal agencies to review the existing regulatory framework as it relates to deemed permitted facilities and help target BMP implementation.
- Provide sufficient funding to existing state and federal cost share programs (urban, agriculture and forestry) for technical assistance and the voluntary implementation of BMPs. This includes cost share programs managed by the NCD&CS Division of Soil & Water Conservation (DSWC) and NC Forest Service (NCFS) and federal programs managed by the USDA Natural Resources Conservation Service (NRCS). Programs should promote BMPs that reduce nutrients, turbidity and bacteria in waterways.
- DWR needs to prioritize water quality monitoring staff at the Regional Offices. Regional offices are struggling to fill and retain field monitoring staff. The lack of field monitoring will limit water quality assessments going forward and fundamentally risk our ability to assess progress on strategy implementation and perform assessments for improved water quality for removal of impaired waters listing. There are recommendations throughout the watershed for additional water quality data needs including special studies, dissolved metal monitoring for impairment confirmation and fecal coliform 5-in-30 sampling.
- Publicly Owned Treatment Works (POTWs) must work with DWR to determine if their Pretreatment Program is sufficiently evaluating indirect dischargers to protect against accepting waste with potential emerging contaminants.
- It is recommended that the NPDES Permitting Branch include instream monitoring for nutrients, fecal coliform bacteria and the full set of physical parameters in all NPDES wastewater permits in order to confirm compliance with instream water quality standards and for assessment and compliance with the TMDL/strategy reductions.
- When resources allow, a DWR Water Sciences Section special study assessing the water quality conditions in the Haw River behind the dam at Saxapahaw during the growing season is recommended since this section is frequently used for recreational purposes and algal blooms have been reported. Reducing nutrients, sedimentation and bacteria are needed to improve and protect the conditions of the Haw River.

- DWR recommends the implementation of the Watershed Action Plans (WATs) and encourages the development of additional community driven WATs to help address water quality impairments and degraded habitats throughout the Haw River Subbasin.
- Encourage the removal or modification of dams or other man-made barriers to promote fish passage, improve biodiversity and the sustainability of healthy fish populations.

### 6.8.3 Haw River Subbasin Local Initiatives

#### *Haw River Assembly (HRA)*

The [Haw River Assembly](#), works to restore and protect the Haw River and Jordan Lake by building a watershed community that shares this vision. The Haw River Assembly is a non-profit organization founded in 1982 and works in eight counties in the Haw River subbasin: Guilford, Rockingham, Caswell, Alamance, Orange, Chatham, Durham and western Wake. The goals of the Haw River Assembly are to promote environmental education, conservation and pollution prevention. Industrial contaminants, sedimentation from poor development practices, stormwater runoff and excess nutrients, microplastics and bacteria pollution not only threaten the Haw River ecosystem and the wildlife that depends on it, but also the drinking water supplies, and recreational waters thousands of North Carolinians rely on. Through community organizing, advocacy, pollution investigation, legislative lobbying, and litigation, Haw River Assembly leads the fight against water quality issues in the watershed.

The Haw River Assembly runs a River Watch volunteer water quality monitoring program which documents water quality and environmental concerns across the Haw River watershed. Information on their monitoring program and watershed results are available at <https://healthofthehaw.org/>.

#### *Haw River Trail*

In 2023, the Haw River Trail became the newest authorized NC State Trail in the NC state parks system. The planned Haw River Trail corridor extends approximately 80 miles along the Haw River, from Haw River State Park on the Rockingham-Guilford county line through Alamance County to Jordan Lake State Recreation Area in Chatham County and is land and paddle trail. The Haw River Trail is part of the state-wide Mountain-to-Sea Trail. The state trails comprise multiple connected sections that rely on local partnerships. The [Friends of Lower Haw River State Natural Area](#), [Carolina Canoe Club](#) and [The Conservation Fund](#) were critical to make this authorization happen. For more information and maps of the land and paddle trails see the Haw River Trail website, <https://thehaw.org>. Other trail information is available at these links:

- <http://www.land4tomorrow.org/haw-river-trail-becomes-a-state-trail/>
- <https://trails.nc.gov/state-trails#Whatisastatetrail-444>
- <https://thehaw.org/>

#### *Clean Jordan Lake*

There are many efforts taking place in the Jordan Lake watershed to improve and protect the water quality in the subbasin. Clean Jordan Lake is specifically dedicated to cleaning the shorelines of Jordan Lake proper. For more information, see section 6.6.6.9.7 above or see their website <https://www.cleanjordanlake.org>.

### *Cape Fear River Assembly*

The [Cape Fear River Assembly \(CFRA\)](#) is a basinwide group of diverse stakeholders from the agriculture, local government, industry, academia, community-based organizations and citizens who strive to maintain and improve the quality of life in the Cape Fear River Basin by encouraging smart management of the river, tributaries, and adjacent land use from a basinwide perspective. The CFRA members often have divergent viewpoints, but they work together to find solutions to water quality and quantity problems impacting the entire river basin. Educational opportunities are provided to improve understanding, encourage dialogue between all interests on important issues and champion various projects that benefit all citizens of the Cape Fear River Basin. The CFRA updated their [strategic plan](#) in 2020.

DWR Basin Planning Branch developed a survey in conjunction with the CFRA and a flyer to be distributed to stakeholders and stewardship groups across the Cape Fear River Basin to bring awareness DEQ's mission and guide efforts in plan development. More information about the survey is available in Chapter 4 section 4.5 on Stakeholder Engagement and in the Chapter 4 Appendix.

See Chapter 4 *Local Initiatives, Funding Opportunities and Land Management* for more information on local initiatives throughout the Cape Fear River basin.

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