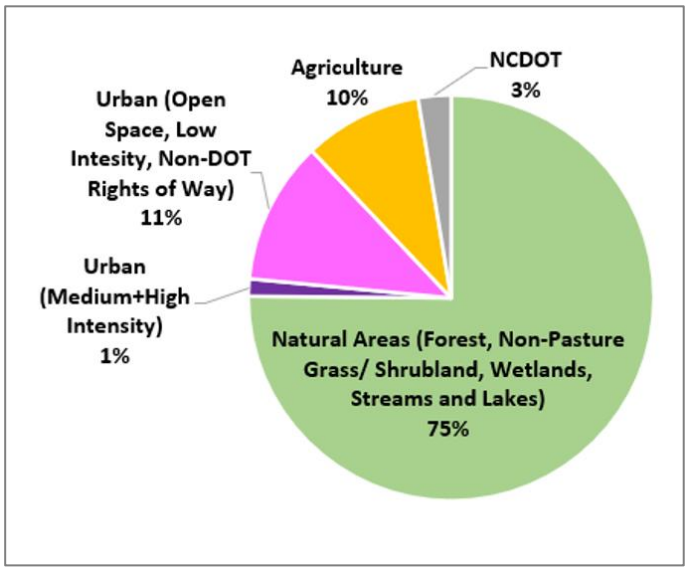
Sources of Nutrient Loading to Falls Lake from 2014 to 2018

The UNRBA developed a watershed model using a computer software program called the Watershed Analysis Risk Management Program (WARMF). This model simulates stream flows and pollutant loading from the tributaries to Falls Lake. The UNRBA watershed modeling report is available in the UNRBA resource library.

The WARMF watershed model was developed to represent the UNRBA study period (2014 to 2018). Land use data is a critical input to the model. Many organizations provided local data. The land use composition of the watershed during the study period is summarized below:



- 75% unmanaged or natural areas with little human impact
  - Important for protection of water quality
  - Difficult to reduce nutrient loading
- 10% is agriculture
  - Half crop, half pastureland
  - Mostly small family farms
  - Best management practices (BMPs) widely implemented
  - Acreage of agriculture has declined by almost one-half since 2006, the tracking year for the 2011 Falls Lake Rules
- 3% is NC Department of Transportation road rights of way
- 11% “less impervious” urban land
  - Developed open space
  - Non-DOT rights of way
  - Low intensity existing development
- 1% “more impervious” urban land
  - Medium intensity development
  - High intensity development

Other data sets are also important to accurately simulate stream flows and nutrient loading to Falls Lake. These data are summarized in the UNRBA watershed modeling report available in the resource library:

- Soils data (chemical and hydrologic properties)
- Stream and impoundment data
- Rainfall and weather data
- Discharges from wastewater treatment plants
- Locations, types, and failure rates for onsite wastewater treatment systems
- Rates and timing of nutrient application by land use
- Crop planting and harvest dates
- Precipitation chemistry and air concentrations of pollutants

Securing the data needed to provide the best configuration of the model was a large and important task. The effort would not have been possible without the cooperation of others. Many stakeholders provided data, information, insights, and feedback to support this effort and ensure that all available information was incorporated accurately:

- Local governments and utilities that comprise the UNRBA (click here for a list of jurisdictions)
- State agencies like the NC Division of Water Resources, NC Department of Agriculture and Consumer Services, NC Department of Transportation, NC Wildlife Resources Commission, and the NC State Climate Office
- Federal agencies like the US Forest Service and US Geologic Survey
- Researchers funded through the NC Collaboratory
- Representatives from the Farm Bureau and American Rivers

Information obtained through this process has been reviewed and quality assured prior to use in the model. The NC Collaboratory provided funding for a "third-party" review of the model. This extensive review resulted in improvements to the model. Source load allocation and simulated loading rates from specific land uses were a significant part of the review. The UNRBA applied consistent assumptions and underlying data sets to characterize the watershed.

WARMF tracks delivered loads from sources in the watershed. Calculated loads are based on the nutrient inputs, processes that affect each source, and transformations that occur on and below land surfaces, in streams, and in impoundments. Agricultural and urban lands receive nutrient application in the model, but unmanaged and natural lands do not.

The loads delivered to Falls Lake are a function of tributary stream flow and water quality concentrations. Delivered loads are strongly dependent on rainfall amounts and prior rainfall conditions as described here.

The following sources are tracked in the model:

- Individual land uses (e.g., deciduous forest, full-season soybeans, developed open space) including
  - Atmospheric deposition
  - Nutrient application
  - Litter fall
- Individual types of onsite wastewater treatment systems (e.g., conventional functioning systems, conventional malfunctioning systems)
- Point sources (includes major and minor dischargers, discharging sand filter systems, and sanitary sewer overflows)
- Initial mass of chemical constituents in the watershed soils, streams, and impoundments
- Stream bank erosion
- Direct wet and dry deposition to Falls Lake

The next page shows the percent contribution and the source of the delivered loads to Falls Lake. Pie charts are provided for total nitrogen, total phosphorus, and total organic carbon. These delivered loads account for nutrient removal due to crop harvesting and processes that reduce loading before delivery to the lake (e.g., setting). The surface of Falls Lake receives direct inputs from the atmosphere as rain or particulate settling.

Three-quarters of the watershed is unmanaged land. These areas include forests, wetlands, unmanaged grassland and shrubland, land in forest succession, and open water. Over one-half of the total nitrogen, total phosphorus, and total organic carbon loads delivered to Falls Lake originates from these areas. Loading from these areas is higher during wet conditions when soils are saturated. Unmanaged lands are important to the health of the watershed. These areas store and cycle nutrients and carbon, infiltrate and store rainwater, buffer temperatures, and provide habitat. Increased loading from forested areas following large rainfall events has been reported by many researchers. The UNRBA Watershed Modeling Report provides a summary of this research.

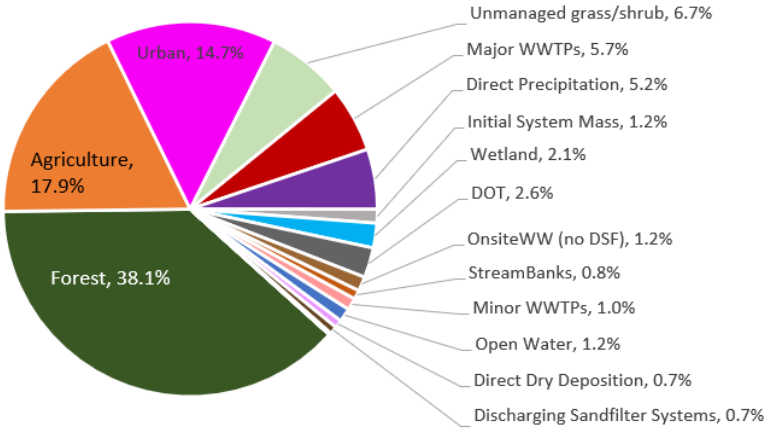
View the links below for additional information on nutrient loading to Falls Lake:

- Historic trends in total nitrogen and total phosphorus loading to Falls Lake
- Importance of precipitation on nutrient loading to Falls Lake

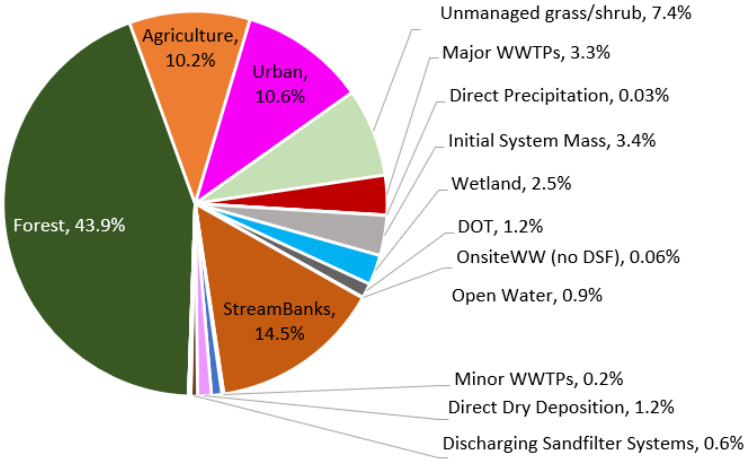
Delivered loads are what reach Falls Lake after the nutrient inputs and watershed processes have been accounted for. Delivered loads represent only 20 percent of "applied' nutrients in the watershed.

Forests, non-pasture grassland, wetlands, and other natural lands contribute approximately half of the nutrient load to Falls Lake because they are most of the drainage area. These areas are important to the health of the watershed and provide many benefits.

Total Nitrogen (1.65 million pounds per year)



Total Phosphorus (183,000 pounds per year)



Total Organic Carbon (13.2 million pounds per year)

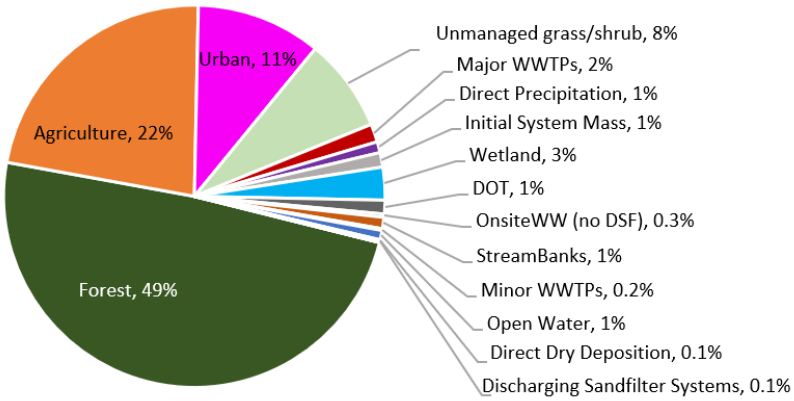


FIGURE NOTES:

Loads from unmanaged areas, including forests, contribute the largest fraction of the load because 75 percent of the watershed is comprised of these areas (see figure on page 1). These areas are important to the health of the watershed.

Loads from wastewater treatment plants (WWTPs) include major and minor discharges as well as sanitary sewer overflows. Loads from WWTPs have been significantly reduced since the baseline year (2006).

Loads from onsite wastewater treatment systems (Onsite WW) are listed separately for discharging sandfilter systems (DSF) and other systems (no DSF).

13% of the watershed is “urban.” 68% of "urban" area is developed open space (mostly non-DOT road right of way) and 20% is existing development, low intensity. Less than 1.5% of the watershed is medium or high intensity development. Thus, most of the “urban” land in the watershed is low intensity.

Loads from streambank erosion are listed separately from urban loads.

Only 9 % of the watershed remains in agriculture. 57% of agriculture is pasture, 12% is full season soybeans, 10% is hay, 7% is double-cropped soybeans, 6% is flue-cured tobacco, 6% is no-till grain corn, and 2% is wheat or other crops. These are mostly small family farms.

Atmospheric deposition affects the entire watershed. Direct deposition and direct precipitation are the amounts falling on lake surfaces.

Initial system mass is the amount of pollutant in the streams and impoundments at the start of the model simulation.