WORKING DRAFT REPORT

A Watershed Perspective on Water Quality Impairments

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NOTICE

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Table of Contents

Acronyms

ATTAINS	Assessment Total Maximum Daily Load (TMDL) Tracking and Implementation System
BMP	Best Management Practice
CALSWAMP	California Surface Water Monitoring Program
EPA	U.S. Environmental Protection Agency
HUC	Hydrologic Unit Code
IRWMP	Integrated Regional Water Management Plan
NARS	National Aquatic Research System
NCDENR	North Carolina Department of the Environment and Natural Resources
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
OCC	Oklahoma Conservation Commission
OKDEQ	Oklahoma Department of Environmental Quality
OWRB	Oklahoma Water Resources Board
PCB	Polychlorinated Biphenyl
SIC	Standard Industrial Classification
SPARROW	Spatially Referenced Regressions on Watershed Attributes
STORET	Storage and Retrieval Data Warehouse
TMDL	Total Maximum Daily Load
USGS	U.S. Geological Survey

Introduction

The purpose of this report is to help the agribusiness sector, non-profit organizations, and state/local governments better understand: the water quality footprint of agricultural supply chains; priority problems; potential causes of impairment; existing studies and data; and key players and stakeholders in six specific watersheds. This report is intended as a tool to help food processors and others working in these watersheds to create targeted and well-informed initiatives.

An adequate supply of clean water is essential for all citizens as well as for the U.S. agribusiness sector. The amount and quality of water can constrain both agricultural production and food processing. For example, irrigated farms need to deliver adequate amounts of water of sufficient quality so plants are not stressed, and the crop yields and quality are not decreased. The health and growth of livestock also depend upon adequate quality water sources. Farm families often get their drinking water from on-farm wells and depend on the quality of this water to protect their family's health. Finally, food processing facilities depend upon a source of high quality agricultural products and adequate supplies of clean water in their manufacturing processes.

Just as important as the quality of the water on the intake is the quality of the discharge, runoff, or groundwater return. Thus it is important for the industry to recognize their dependence on supplies of clean water and that agricultural production and food processing can have negative impacts on water quality. Agricultural activities can elevate concentrations of nutrients, sediment, pesticides, and fecal coliform in water sources. Nutrient loading in the runoff from over application of chemical fertilizers and manure can damage aquatic ecosystems, lead to eutrophication of

Watershed Approach

The watershed approach is a coordinating framework for environmental management that focuses public and private sector efforts to address the highest priority problems within hydrologically defined geographic areas, taking into consideration both ground and surface water flow.

Besides driving results towards environmental benefits, the approach can result in cost savings by leveraging and building upon the financial resources and the willingness of the people with interests in the watershed to take action. Through improved communication and coordination the watershed approach can reduce costly duplication of efforts and conflicting actions.

The watershed approach strengthens teamwork between the public and private sectors at the federal, state, tribal, and local levels to achieve the greatest environmental improvements with the resources available. This emphasis gives those people who depend on the aquatic resources for their health, livelihood or quality of life a meaningful role in the management of the resources. Through such active and broad involvement, the watershed approach can build a sense of community, reduce conflicts, increase commitment to the actions necessary to meet societal goals and, ultimately, improve the likelihood of sustaining long-term environmental improvements.

The guiding principles of the watershed approach are:
Partnerships – Those most affected by management decisions are involved throughout and shape key decisions.
Geographic focus – Activities are directed within specific geographic areas, typically the areas that drain to surface water bodies or that recharge or overlay ground waters or a combination of both.
Sound management techniques based on strong science and data – Collectively, watershed stakeholders employ sound scientific data, tools, and techniques in an interactive decision-making process.[1]

water bodies, and threaten public health, e.g., by affecting the quality of water in on-farm drinking wells. Food processing facilities can also add nutrients and other pollutant loadings to the water bodies that receive their wastewater discharges.

In addition to impacting the productivity of agribusiness itself, such water impairments also have negative impacts on drinking water supplies, impart additional costs to municipalities for water treatment, reduce recreational opportunities, and harm businesses that rely on healthy ecosystems, such as tourism and commercial fishing. As a result, addressing agribusiness impacts on water quality is a priority for a variety of public and private organizations throughout the United States. Numerous programs exist to encourage farms and food processors alike to reduce their impacts on water quality. Public and private organizations are joining to create multi-disciplinary and multi-jurisdictional partnerships to focus on these problems through the community at the watershed scale. The watershed approach provides an effective framework for the organizations to restore, maintain, and protect water resources in the United States. Supporting this approach is a priority for the water programs of the U.S. Environmental Protection Agency (EPA). EPA supports the watershed approach by building effective outreach, development, and planning tools.

By providing information on individual watersheds and the agribusiness activity within those watersheds, this report aims to promote the combined use of two effective tools to improve environmental performance in the agribusiness sector: an industry sector approach and a watershed approach.

In some watersheds, opportunities may exist for agribusiness partnership programs that leverage both the business ties between agricultural producers and food processors and their mutual dependence upon adequate supplies of clean water. Watershed-specific consortiums of industry partners may be able to align their supply-chain programs to address specific water quality impacts.

The report summarizes existing data on the following six watersheds:

- Tulare-Buena Vista Lakes
- Wisconsin and Minnesota Rivers
- Elkhorn River
- Chesapeake Bay
- Neuse River
- Illinois River

These watersheds were selected to represent a variety of sizes, agricultural products, water quality impairments, and available water quality data. Each of these watersheds has significant water quality impairments that are, to varying degrees, the result of agribusiness activities within the watershed. Each watershed has also been the subject of existing environmental studies assessing the water quality impacts and/or has an active and ongoing partnership or association of stakeholders working to improve the watershed's environmental performance.

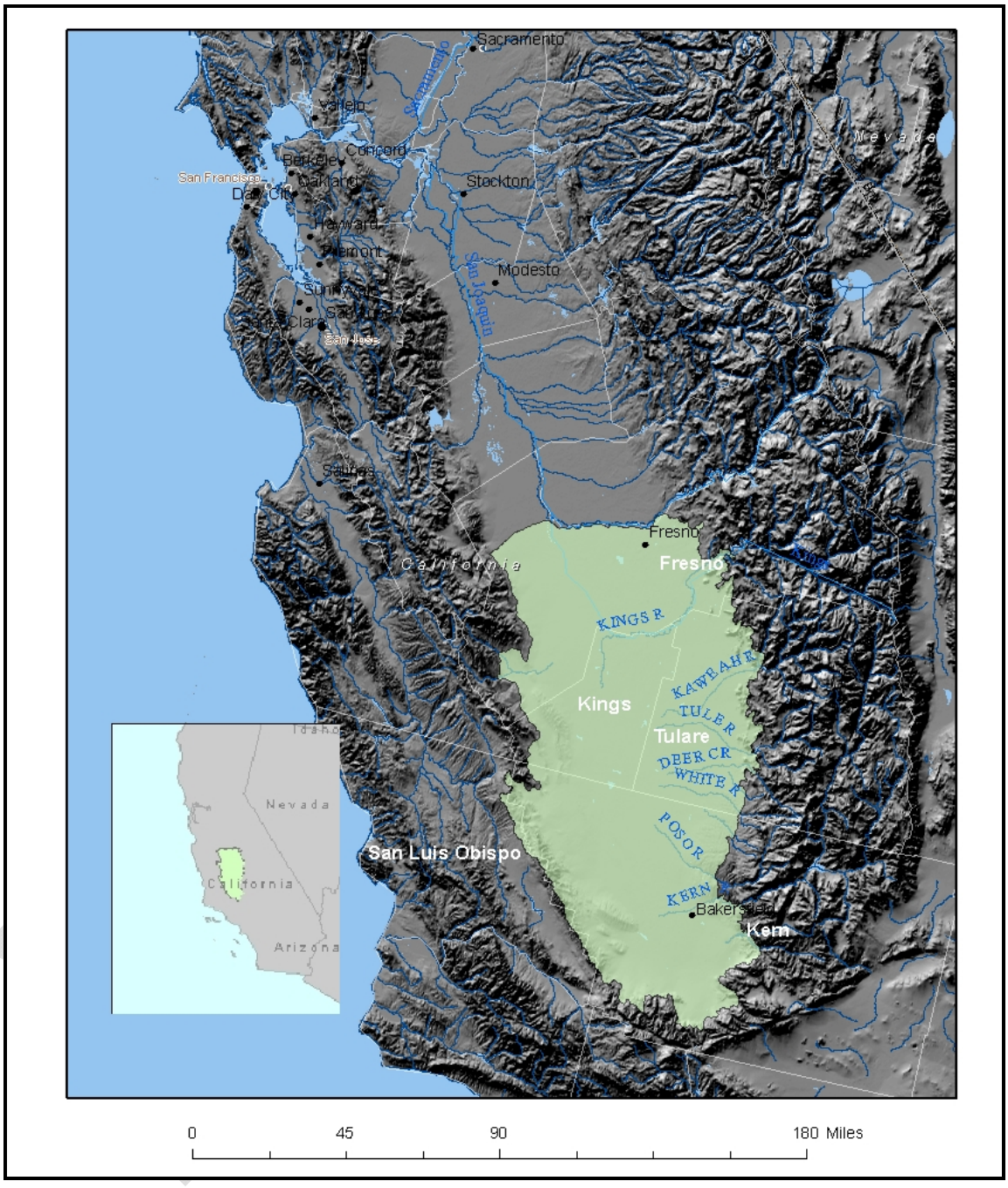
Each watershed assessment is organized into the following sections:

- Introduction

- Agriculture
- Food Manufacturing
- Municipalities
- Impairments and Concerns
- Water Quality Monitoring Stations
- Studies and Initiatives

Most data used to compile the watershed assessments were obtained from the most recently available public sources as of July 2008.

Tulare-Buena Vista Lakes Watershed



Tulare-Buena Vista Lakes Watershed Summary	
Area	• 5,446,440 acres
Location	• California • Tulare Basin in the Southern portion of the Central Valley • Kings, Kern, Fresno, and Tulare Counties
Population	• 1.88 million in 2000
Land Use	• ~50% farmland • ~23% of all land is irrigated
Agriculture	• ~ 50% of farmland is dedicated to crops • Orchards, cotton, and forage account for 74% of total acres harvested • Large dairy industry (>700,000 dairy cows) concentrated in Tulare County • Significant broiler industry concentrated in Kings County
Food Manufacturing	• 55 federally regulated food processing facilities • Most common industries include dairy manufacturing, frozen fruits, juices and vegetables, animal feed, and wine products • Large federally regulated corporations include Kraft Foods, Foster Farms, Cargill, Pepsi, and Leprino Foods
Municipalities	• Projected population to 3.5 million by 2030 • Watershed has 21 federally-regulated wastewater treatment facilities with 3 holding "major" designations under the National Pollutant Discharge Elimination System
Impairments and Concerns	• Key pollutants detected include elevated salinity, nitrates, metals, and pesticides • High salinity attributed to surface or subsurface agricultural drainage • Several studies indicated that fish testes contained elevated levels of copper, arsenic, toxaphene, and Group A pesticides • Mendota Pool and Lower Kings River listed on the Threatened and Impaired Waters list (303(d)) • All 8 waterbodies in the Tulare-Buena Vista Lakes Watershed listed as "impaired" in the Water Quality Inventory Report (305(b)) • Almost 40% of Impairments are caused by flow alterations
Studies and Initiatives	• The California Partnership for the San Joaquin Valley • Integrated Regional Water Management Plans in the Tulare Lake Hydrologic Region and Kings River • U.S. Geological Survey National Water Quality Assessment Program San Joaquin-Tulare Basin study Area concentrating primarily in areas closest to the Sacramento-San Joaquin Delta

Introduction

The Tulare-Buena Vista Lakes watershed encompasses 5,446,400 acres and includes major portions of Fresno, Kings, Tulare, and Kern counties, as well as marginal areas of the Madera and San Luis Obispo counties. The watershed is contained within the California-delineated Tulare Lake Hydrologic Region (see Note) in the Tulare Basin of the southern portion of California's Central Valley region. The Tulare-Buena Vista Lakes watershed is considered a closed hydrologic entity because the surface water drains north into the San Joaquin River only during years of significant rainfall.[2] Average precipitation ranges between seven to ten inches, increasing towards the east, with most of the annual rainfall occurring between the months of November and April.[3]

The Kings River is one of the largest rivers in the Tulare-Buena Vista Lakes watershed flowing for 252 miles from the Sierra Nevada foothills across the San Joaquin Valley. It flows through portions of Fresno, Tulare, and Kings Counties. The River provides a water supply to more than one million people and nearly 20,000 farms. Its waters are stored in the one million acre-feet Pine Flat Reservoir, which is controlled by the Pine Flat Dam; the reservoir is used primarily for flood control, irrigation, recreation, and hydroelectricity.[4]

Other major rivers in the region include the Kaweah, Tule, and Kern Rivers, which also drain into the valley floor. Historically, the Kings and Tule Rivers terminated at the Tulare Lake, once the largest freshwater lake in the western portion of the United States. The Kern River terminated at the Kern and Buena Vista Lakes. All of these lakes have been dry for several decades, and the waters that used to sustain them have long been diverted into irrigation; the floors of these lakes are now primarily farm land.

Note on Hydrologic Regions, Watersheds and Basins

While the Tulare-Buena Vista Lakes Watershed is the focus of this report, the state of California delineates its drainage basins differently from the system used by the Federal government. California divides the state into 10 individual Hydrologic Regions based on the state's major water drainage basins. The Tulare Lake Hydrologic Region primarily encompasses portions of four counties, Kings, Kerns, Fresno, and Tulare, and covers an area of 10,901,120 acres.

The Federal system is more detailed as it delineates watersheds at the 8-digit hydrologic unit code (HUC), with the Tulare-Buena Vista Lakes Watershed identified as 18030012. The Tulare-Buena Vista Lakes watershed encompasses an area of 5,446,400 acres, most of which is contained within the Tulare Lake Hydrologic Region.

In compiling data for this report, county, state, and federal data are utilized. Distinctions are made between data that applies to the Tulare Lake Hydrologic Region, the Tulare-Buena Vista Lakes Watershed, the counties contained within each, and the Tulare Basin, the southern portion of the Central Valley which incorporates both the Tulare-Buena Vista Lakes watershed and the Tulare Lake Hydrologic Region. Because the hydrologic boundaries differ from county boundaries, the county-level agricultural data presented in this report actually cover a larger area than the Tulare-Buena Vista Lakes Watershed. However, because most of the agricultural areas of the counties are found within the boundaries of the watershed, the county level agricultural data presented in this report are believed to approximately represent the state of agriculture in the Tulare-Buena Vista Lakes Watershed.

The Tulare Lake Hydrologic Region also contains twelve groundwater basins and seven subbasins. These basins underlie nearly half of the entire hydrologic region or 5.33 million acres. The region's groundwater is exceedingly important as it serves as a local supply for 41 percent of the agricultural and municipal use.[5] Groundwater recharge

occurs from stream and river seepage, as well as deep percolation from irrigation, canal seepage, and intentional recharge.

Water supplies in the region are delivered to their end-users via an intricate system of canals, channels, and pipelines; some of the major water conveyance facilities deliver water from sources outside of the region, including the California Aqueduct, the Friant-Kern Canal, and the Cross Valley Canal.[6]

The Tulare Basin is an important agricultural center, with industries such as food processing and packaging prominent in the area. Another important industry sector is oil production. According to the San Joaquin Geological Society, Kern County alone provides as much as 10 percent of the total oil production of the United States.[7]

Agriculture

In the Tulare Lake Hydrologic Region smaller farms are being consolidated into larger enterprises. Between 1997 and 2002, on average the number of farms declined by 8.25 percent; at the same time, the average farm size increased by almost 8 percent.[8] As measured by total value of production, the counties of the Tulare-Buena Vista Lakes watershed include three of the top five agricultural counties in the state. More than 15 percent of California's farmland is found in these three counties. Although portions of Kern and Fresno counties lie outside of the Tulare-Buena Vista Lakes watershed, those areas rely more heavily on recreation and tourism as they lie in the mountainous region of the Sierra Nevada. Thus, land-use data on irrigation, cropland, and pastureland in these counties is likely to be a good representation of land use for the watershed (Table 2-1).[9]

Table 2-1: 2002 Tulare Lake Hydrologic Region Land Use

Total Area of Tulare Lake Hydrologic Region (acres)	10,901,120
Total Area of Tulare-Buena Vista Lakes Watershed (acres)	5,446,400
Total County Area[a] (acres)	13,003,936
Land in Farms (acres)	6,699,260
Land in Farms as Percent of Total County Area	52%
Cropland (acres)	3,498,245
Cropland as Percent of Land in Farms	52%
Pastureland (acres)	3,007,952
Pastureland as Percent of Land in Farms	45%
Irrigated Land (acres)	2,970,029
Irrigated Land as Percent of Total County Area	23%

[a] Includes total area of King, Kern, Tulare, and Fresno Counties.
Source: 2002 Census of Agriculture (U.S. Department of Agriculture). California County Level Data.

The top crops produced in the area are grapes, alfalfa, nuts, cotton, and vegetables (Table 2-2). The four-county region also has a large dairy industry, with more than 700,000 dairy cows. Tulare County leads the state and the nation in dairy production, with more than 400,000 dairy cows producing milk worth more than one billion dollars in 2006.[10, 11]

Table 2-2: 2002 Census Year Harvested Crops and Livestock Inventory for Counties[a] of the Tulare Lake Hydrologic Region					
	Kings	**Fresno**	**Kern**	**Tulare**	**Total***
Crops Harvested (acres)					
All Cotton	159,530	218,333	138,596	58,946	**575,405**
Barley for Grain	1,610	3,095	6,233	1,589	**12,527**
Corn for Grain	3,732	5,223	1,696	3,219	**13,870**
Corn for Silage	38,379	23,684	33,062	116,752	**211,877**
Dry Edible Beans (excluding limas)	7,387	4,757	5,143	3,514	**20,801**
Forage (including alfalfa)	93,134	102,165	133,655	168,110	**497,064**
Land in Orchards	48,425	465,412	349,041	330,463	**1,193,341**
Oats for Grain	962	2,794	1,013	1,287	**6,056**
Peanuts for Nuts	(D)	(D)	-	-	**-**
Potatoes	-	21	24,951	(D)	**24,972**
Rice	-	6,048	-	-	**6,048**
Sorghum for Grain	-	(D)	930	(D)	**930**
Sorghum for Silage	1,042	382	251	279	**1,954**
Sugarbeets for sugar	3,288	13,330	3,402	1,091	**21,111**
Sunflower Seeds	-	13	(D)	-	**13**
Sweet Potatoes	-	362	215	(D)	**577**
Vegetables (harvested for sale)	19,676	199,321	71,672	6,537	**297,206**
Wheat for Grain	47,339	41,755	38,876	30,921	**158,891**
Livestock Inventory (number)					
Beef Cows	5,130	23,422	36,779	31,171	**96,502**
Broilers	(D)	79,359,371	(D)	14,239,657	**93,599,028**
Hogs and Pigs	765	6,341	1,486	(D)	**8,592**
Layers	(D)	(D)	(D)	(D)	**-**
Milk Cows	138,292	90,550	74,708	412,462	**716,012**
Sheep and Lamb	(D)	38,112	121,593	64,913	**224,618**

[a] Includes area of King, Kern, Tulare, and Fresno Counties.
* The Tulare-Buena Vista Lakes watershed encompasses portions of Kern, Kings, Tulare, and Fresno counties. Because the watershed boundaries differ from county boundaries, the data presented here actually represent a larger area than the watershed. However, most of the area which falls outside the watershed is agriculturally unproductive and scarcely inhabited.
Source: 2002 Census of Agriculture (U.S. Department of Agriculture)
Note: (D) signifies that data was withheld to avoid disclosing data for individual farms. "-" represents zero.

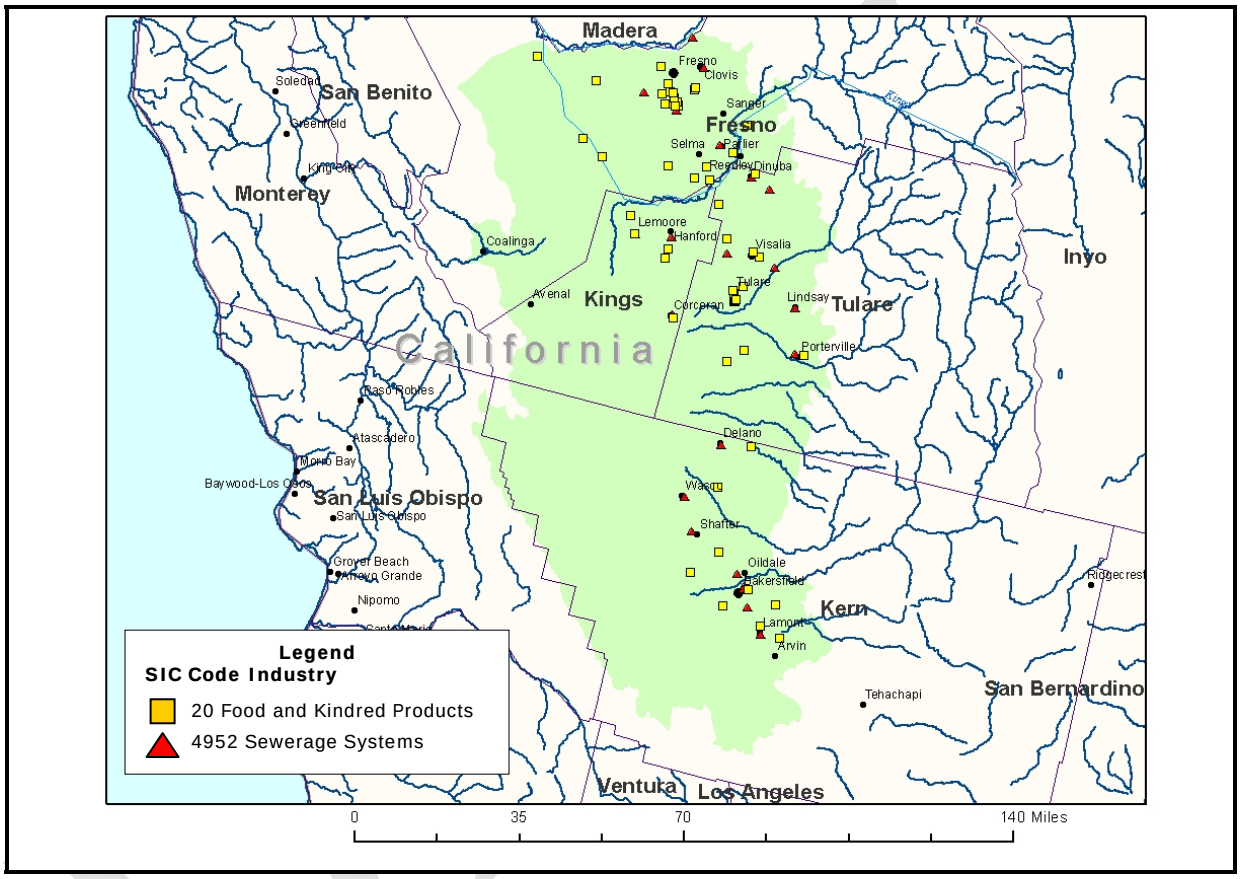
Food Manufacturing

The Tulare-Buena Vista Lakes Watershed is one of California's most productive farming and food manufacturing areas. EPA's Integrated Data for Enforcement Analysis (IDEA) system* showed 55 federally regulated food

* The Integrated Data for Enforcement Analysis (IDEA) system is a single source of environmental performance data on EPA-regulated facilities. IDEA maintains copies of the Agency's air, water, hazardous waste and enforcement source data systems that are updated monthly. IDEA uses "logical" data integration to provide a comprehensive historical profile of inspections, enforcement actions, penalties assessed and toxic chemicals released, for any EPA-regulated facility.

processing facilities in the watershed, the most common of which are manufacturers of dairy, vegetables, animal feed, and wine products (Figure 2-1, Table 2-3). However, many smaller food processing facilities either do not discharge pollutants into waters of the United States and thus do not have NPDES permits or they are "minor" dischargers and are not reported to the federal level. Thus, the data do not include the entire population of food processors in the watershed. In fact, the county-level Census of Manufacturers data for 2002 shows more than 250 establishments in the food manufacturing sector in Kings, Fresno, Kern, and Tulare counties (Table 2-4).[12]

Figure 2-1: Food Manufacturing and Water Treatment Facilities in the Tulare-Buena Vista Watershed



Source: Data generated from EPA's IDEA system for Food and Kindred Products Manufacturing, July 2008. Federal permits and identifiers considered include NPDES permits, Clean Air Act air permits, Resource Conservation and Recovery Act hazardous waste IDs, and Toxic Release Inventory reporters between 2004 and 2006.

Table 2-3: Federally Regulated Food Product Facilities in the Tulare-Buena Vista Watershed

Standard Industrial Classification (SIC) Code: Industry Description	Facility Name	City	NPDES Water Permit (Y/N)
2011: Meat Packing Plants	Beef Packers Incorporated	Fresno	No
	Harris Ranch Beef Co.	Selma	No
	Cargill Meat Solutions Corp.	Fresno	No
2015: Poultry Slaughtering and Processing	Foster Farms Fresno Poultry	Fresno	No
	Foster Farms Porterville	Porterville	No
	Zacky Farms Chicken Plant	Fresno	No
2021: Creamery Butter	California Dairies Inc. Tipton	Tipton	Yes
	California Dairies Inc Fresno	Fresno	No
	Land O'Lakes Incorporated	Tulare	No
2022: Natural, Processed, and Imitation Cheese	Kraft Foods Tulare South	Tulare	No
	Kraft General Foods Incorporated	Tulare	No
	Leprino Foods Company	Lemoore	No
	Kraft Foods Incorporated	Visalia	Yes
	Saputo Cheese USA Inc.	Tulare	No
	Leprino Foods Company	Lemoore	No
2024: Ice Cream and Frozen Desserts	Ice Cream Partners USA LLC.	Tulare	No
	Ice Cream Partners USA LLC.	Bakersfield	No
2026: Fluid Milk	Producers Dairy Foods Inc.	Fresno	No
	Foster Farms Dairy	Fresno	No
2032: Canned Specialties	Real Fresh Incorporated	Visalia	No
2033: Canned Fruits, Vegetables, Preserves, Jams, and Jellies	Hunt Wesson Inc.	Helm	No
	Odwalla	Dinuba	No
	Del Monte Foods Plant Number 24	Hanford	No
2037: Frozen Fruits, Fruit Juices, and Vegetables	Sunkist Growers San Joaquin Valley Processing Plant	Tipton	No
	Premier Packing Incorporated	Shafter	No
	Grimmway Ents Incorporated Mount View Facility	Lamont	No
	Delano Growers Grape Products	Delano	No
2041: Flour and Other Grain Mill Products	Miller Milling Co.	Fresno	No
2048: Prepared Feeds and Feed Ingredients for Animals and Fowls	Foster Farms Kingsburg Commodities	Kingsburg	No
	Cargill, Inc.	Hanford	No
	Foster Farms Burrel Feedmill	Burrel	No
	Louis Rich Co.	Goshen	No
	Foster Farms Traver Feedmill	Traver	No
	Imperial Western	Selma	No
2051: Bread and Other Bakery Products, Except Cookies and Crackers	Earthgrains Baking Co.	Fresno	No
2063: Beet Sugar	Spreckels Sugar Company	Mendota	No
2074: Cottonseed Oil Mills	J. G. Boswell Company Oil Mill	Corcoran	No

Table 2-3: Federally Regulated Food Product Facilities in the Tulare-Buena Vista Watershed

Standard Industrial Classification (SIC) Code: Industry Description	Facility Name	City	NPDES Water Permit (Y/N)
	Anderson Clayton Corporation	Fresno	No
	Ranchers Cotton Oil	Fresno	No
2077: Animal and Marine Fats and Oils	Darling International Inc.	Fresno	No
	Baker Commodities Inc.	Kerman	No
2084: Wines, Brandy, and Brandy Spirits	Franzia Sanger	Sanger	No
	Guild Wineries and Distilleries Gibari Wine	Fresno	No
	E & J Gallo Winery	Fresno	No
	Giumarra Vineyards Corp.	Edison	No
	Golden State Vintners	Parlier	No
	Heck Cellars Winery	Di Giorgio	No
	Franzia Winery	Tulare	No
2085: Distilled and Blended Liquors	Sun Maid Growers of CA	Kingsburg	No
2086: Bottled and Canned Soft Drinks and Carbonated Water	Pepsi Cola Bottling Company Bakersfield	Bakersfield	No
	Pepsi Cola- Fresno	Fresno	Yes
2087: Flavoring Extracts and Flavoring Syrups, NEC	Franzia McFarland	McFarland	No
	San Joaquin valley Concentrates	Fresno	No
2096: Potato Chips, Corn Chips, and Similar Snacks	Recot Incorporated	Bakersfield	No
2099: Food Preparations, NEC	Tulare Cultured Specialties	Tulare	No

Source: Data generated from EPA's IDEA system for Food and Kindred Products Manufacturing. Federal permits and identifiers considered include the NPDES permits, Clean Air Act air permits, Resource Conservation and Recovery Act hazardous waste IDs, and Toxic Release Inventory reporters between 2004 and 2006.

Table 2-4: Number of Food Manufacturing Establishments in the Counties of the Tulare-Lake Hydrologic Region

County	Number of Food Manufacturing Establishments
Kings	27
Fresno	123
Kern	44
Tulare	59

Source: U.S. Census Bureau. 2002 Economic Census of Manufacturing. North American Industry Classification System code 311

Municipalities

The San Joaquin Valley has been experiencing some of the fastest rates of population growth in the state of California. The population of the Tulare Lake Hydrologic Region was at 1.88 million in the year 2000 and was expected to grow at 18 to 22 percent in the following decade. The California Department of Finance has projected that by the year 2030, the region's population would be approaching 3.5 million.[13] The areas with some of the densest populations are metropolitan areas of Fresno, Clovis, Bakersfield, and Visalia. Population densities vary by county, and some large areas of the region have almost no residents at all.

The Tulare-Buena Vista Lake watershed's significant rise in population will mostly be concentrated in the major urban areas of the region. Due to the watershed's closed hydrologic characteristics, water treatment facilities play an increasingly important role in the regional water recycling and conservation efforts. According to EPA's IDEA system, there are 21 wastewater treatment facilities with National Pollutant Discharge Elimination System (NPDES) permits in the Tulare-Buena Visa Watershed. The cities of Visalia, Cutler, and Fresno have wastewater treatment plants with 'major' designations under the NPDES Program[†] (Table 2-5).

Table 2-5: Municipal Wastewater Treatment Facilities

Name	City	NPDES Water Permit
Visalia	Visalia	Major
City of Porterville	Porterville	Minor
Cutler-Orosi JT Powers	Cutler	Major
Malaga	Fresno	Major
City of Corcoran	Corcoran	Minor
City of Dinuba	Dinuba	Minor
City of Farmersville	Farmersville	Minor
Lamont Pud	Lamont	Minor
City of Lindsay	Lindsay	Minor
City of Parlier	Parlier	Minor
City of Shafter	Shafter	Minor
Wasco	Wasco	Minor
Bakersfield #2	Bakersfield	Minor
Lemoore City	Lemoore	Minor
Fresno Waste Water Management	Fresno	Minor
City of Delano	Delano	Minor
Kern Co Sani Authority /Mt. Vernon	Bakersfield	Minor
North of River SD #1	Bakersfield	Minor
City of Bakersfield	Bakersfield	Minor
City of Hanford Corporation Yard	Hanford	Minor
North Fresno	Fresno	Minor

Source: Data generated from EPA's IDEA system for Sewerage Systems. Federal permits and identifiers considered include NPDES permits, Clean Air Act air permits, Resource Conservation and Recovery Act hazardous waste IDs, and Toxic Release Inventory reporters between 2004 and 2006.

[†] Each NPDES permit holder is defined by the program office as a Major or Minor discharger. Classification as a major discharger generally involves factors relating to the significance of the discharger's impact on the environment, such as nature and quantity of pollutants discharged, character and assimilative capacity of the receiving waters, presence of toxic pollutants in the discharge, and discharger's compliance history.

Ground Water Impairments and Concerns

High salinity is a major water quality concern in the Tulare Lake Hydrologic Region and its underlying groundwater basins.[14] Both geologic and human factors contribute to this impairment, which is exacerbated by the fact that the regions' rivers and groundwater generally do not flow out of the basin.

At the end of the 19th century, increasing extraction of groundwater for development began to change the basins' groundwater flows. By early and mid 20th century the basin experienced lowering of groundwater tables in the east, and significant land subsidence in the southern and western portions, with some areas experiencing subsidence of over 20 feet. Due to several state and federal projects, such as the State Water Project and the Central Valley Project respectively, subsidence was largely stopped with increased importation of surface water from the north side of the state and the San Joaquin River. However, the imported surface water, about one-third of the amount of natural flow into the basin, contains levels of salt that are nearly twice the amount of salt found in the natural flows.[15]

Because there is no natural outlet to the ocean, both local and imported salt concentrates in the basin, accumulating in the groundwater and often leading to increased surface water salinity when groundwater inflows significantly contribute to stream and river flow. Similarly, use of salinated surface water in activities such as irrigation increases the salinity levels of soil and shallow groundwater.[16] Besides changes in groundwater flow patterns due to development, agricultural activities are recognized as a major contributor to the basin's elevated salt levels. According to the Initial Draft of the 2009 California Water Plan Update, the large concentration of dairy operations in the region is believed to be a major source of salinity, microbes, and nutrients. The Water Plan Update also states that over 400 square miles of the basins' groundwater is contaminated with nitrates.[17] Other factors that may be exacerbating the region's predisposition to elevated salinity are food processing facilities, municipal water treatment plants, and oilfield brines.[18]

Additional impairments that afflict groundwater in the basin include fine sediment, fertilizer, and pesticides such as arsenic and dibromochloropropane, a soils fumigant once commonly used on grapes. Most of these pollutants are attributed to leaching from agricultural lands and have largely been detected along the east side of the basin which has higher soil permeability and water tables.[19]

Withdrawals of water exceeding the amount naturally replenished continue to be a significant concern in the Region. The efficient use of scarce water requires preserving and/or recovering water of sufficient quality for intended uses, including instream uses for aquatic life and wetlands. Due to the semi-arid conditions, irrigation efficiency is a top priority, although conservation also has the potential to exacerbate the concentration of salts and pollutants on the land. The 10-inch average annual rainfall significantly falls short of average annual crop requirements of 50 inches. The Kings River is the main surface water resource in the area and supplies water to farms and cities as well as recharge of the groundwater basin.[20] Supplies are proving to be insufficient to support the high level of agriculture and other development taking place, leading to an increasing reliance on groundwater

or a combination of surface and groundwater supplies. Major population centers, like Visalia and Fresno, are almost entirely dependent on groundwater for supplies.[21]

Surface Water Impairments and Concerns[‡]

The 2006 California Clean Water Act Section 303(d) Threatened and Impaired Waters List, which lists waterbodies that are impaired or are threatened to be impaired by pollutants, has the following two waters listed for the Tulare-Buena Vista Lakes Watershed: Mendota Pool, a freshwater reservoir in Fresno County, and the Lower Kings River.

While Mendota Pool is impaired due only to high selenium concentrations, the Lower Kings River is impaired by metals such as molybdenum; pesticides such as Toxaphene; and other pollutants such as sulfates, chlorides, total dissolved solids, and elevated salinity levels, measured as specific conductivity (Table 2-6).

Table 2-6: 2006 Tulare-Buena Vista Lakes Watershed 303(d) Threatened and Impaired Waters List

Waterbody Name	Cause of Impairment
Mendota Pool	Selenium
Lower Kings River	Molybdenum
	Specific conductivity
	Toxaphene

Source: EPA Assessment TMDL Tracking and Implementation System (ATTAINS) database for 2006. Data obtained from <http://iaspub.epa.gov/waters10/attains_index.control?p_area=CA> Accessed on July 21, 2008.

According to the California Regional Water Quality Control Board for the Central Valley Region, the source of salinity in the Lower Kings River can be attributed to either surface or subsurface agricultural drainage.[22] The 2002 Watershed Management Initiative's State of the Watershed Report for the Tulare Basin stated that the river occasionally had elevated levels of conductivity and total dissolved solids, and that fish tested from the river contained elevated levels of copper, arsenic, toxaphene, and Group A pesticides.[23] A Total Maximum Daily Load[§] (TMDL) for the Lower Kings River is not a high priority and is not anticipated to be completed until 2015.

The California 2004 Clean Water Act Section 305(b) National Water Quality Inventory Report, which discloses conditions of all waterbodies in the state including causes of impairment from types of pollution and likely sources of pollution, has all eight waterbodies in the Tulare-Buena Vista Lakes Watershed listed as “impaired” (Table 2-7).

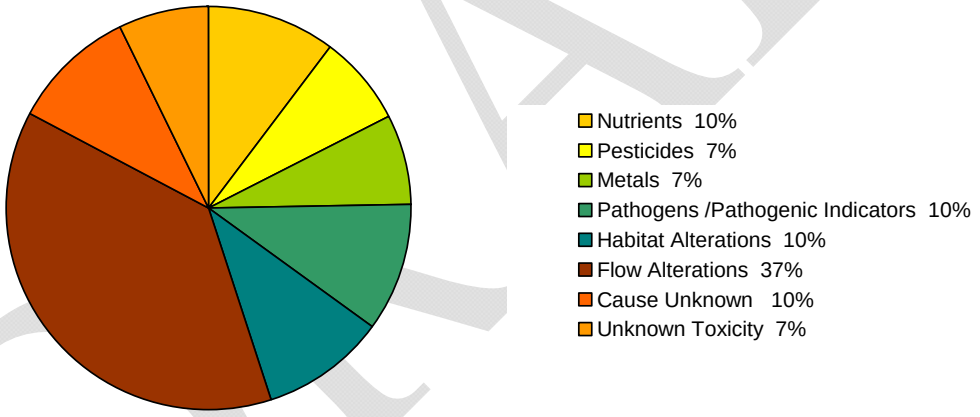
[‡] The impairments cited here represent the monitoring activities taking place in the watershed and may not reflect the complete condition of the watershed.
[§] A Total Maximum Daily Load (TMDL) is a regulatory term in the U.S. Clean Water Act, describing a value of the maximum amount of a pollutant that a body of water can receive while still meeting water quality standards.

Table 2-7: 2004 Tulare-Buena Vista Lakes Watershed 305(b) Report	
Waterbody Name	**Water Status**
Cantua Creek	Impaired
Deer Creek (Tulare County)	Impaired
Lower Kaweah River (including St. Johns River)	Impaired
Lower Kern River	Impaired
Lower Kings River (Island Weir to Stinson and Empire Weirs)	Impaired
Los Gatos Creek	Impaired
Mendota Pool	Impaired
Lower Tule River	Impaired

Source: EPA ATTAINS database for 2006. <http://iaspub.epa.gov/waters10/attains_index.control?p_area=CA> Accessed on July 21, 2008.

Out of the nearly 500 miles of assessed waters with listed causes of impairment, the majority of impairment is due to flow alterations, with another third due to impairments such as pathogens, metals, pesticides, and nutrients, all of which are often attributed to agriculture (Figure 2-2).[24] The lack of a natural drainage to the ocean also contributes to the build up of pollutants in the region.

Figure 2-2: Causes of 305(b) Waterbodies Impairment as Percent of Total Miles Assessed



Source: EPA ATTAINS database for 2006. <http://iaspub.epa.gov/waters10/attains_index.control?p_area=CA> Accessed on July 21, 2008.

Water Quality Monitoring Stations

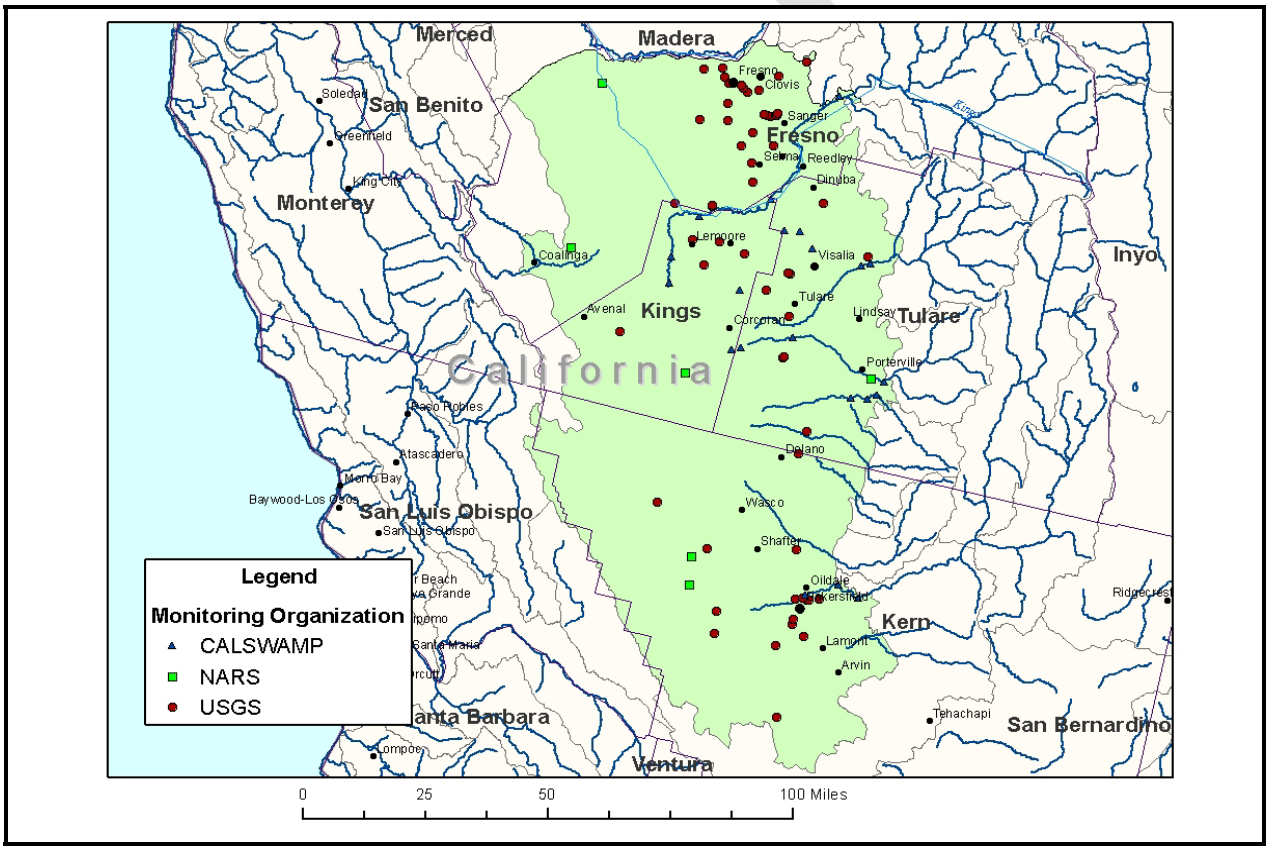
There are a number of organizations that routinely monitor water quality in the four counties of the Lake Tulare Hydrologic Region. While various organizations focus their monitoring efforts on particular pollutants, most report to EPA's Storage and Retrieval Data Warehouse (STORET). STORET is a data management system containing water quality information for the nation's waters. In the Lake Tulare Hydrologic Region, more than 30 state and regional organizations report water quality data to the STORET database, including the California Surface Water Monitoring Program (CALSWAMP) and the National Aquatic Resource Survey (NARS) (Table 2-8, Figure 2-3). A prominent local resource management agency, the Kings River Conservation District, has been

monitoring water quality in the Kings River since 1978 and has 125 unique site locations with more than 15 thousand detailed data records through 1999. The program also collected samples between 2004 and 2006, and is committed to continue its ongoing monitoring efforts. The U.S. Geological Survey's (USGS) National Water Information System stores water quality data of more than 1.5 million sites throughout the country and conducts monitoring for the entire spectrum of impairments as well as quantity, distribution, and movement of water parameters. The USGS has the most stations in the area, with 66 operating in the Tulare-Buena Vista watershed.

Table 2-8: Water Quality Monitoring Stations in the Tulare-Buena Vista Lakes Watershed**

County	Monitoring Organizations		
	USGS	CALSWAMP	NARS
Kings	5	5	1
Fresno	35	1	2
Kern	16	3	2
Tulare	10	15	1

Figure 2-3: Water Quality Monitoring Stations in the Tulare-Buena Vista Watershed



Source: EPA's STORET, USGS National Water Information System.

** Monitoring stations active between 2002 to present, with at least one type of water quality parameter tested at the site. Monitoring station data collected from USGS National Water Information System and STORET databases.

Studies and Initiatives

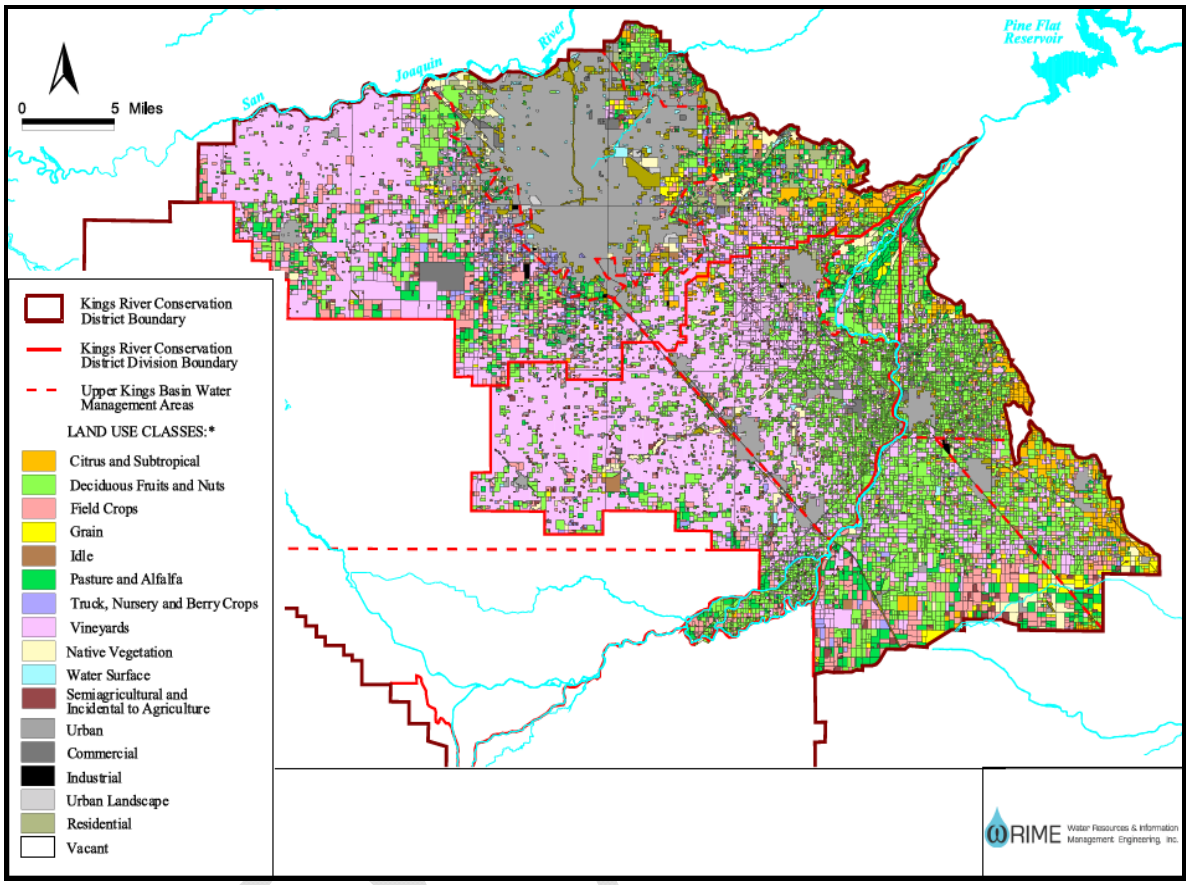
The California Partnership for the San Joaquin Valley was established in 2005 to address water quality, supply, and reliability issues by implementing comprehensive Integrated Regional Water Management Plans (IRWMP) in the San Joaquin River and Tulare Lake Hydrologic Regions. Currently there are four IRWMPs in the Tulare Lake Hydrologic Region, varying in function and development. The Kings River IRWMP is located in the northern central portion of the region; the Kaweah IRWMP is adjacent to the south. The Poso Creek IRWMP is located in the southern portion of the region and the Westside IRWMP spans both the San Joaquin River and the Tulare Lake Hydrologic Regions. Within the Tulare Lake Hydrologic Region, the Westside IRWMP generally occupies the north western portion.

The Kings River IRWMP is one of the largest and most comprehensive initiatives in the Tulare-Buena Vista Lakes watershed. A primary goal of the Kings River IRWMP is addressing groundwater recharge and groundwater banking as a means of improving surface water quality in the region. A major contributor to the progress of the Kings River IRWMP is the Upper Kings River Water Forum lead by the Kings River Conservation District, which has been monitoring and assessing the Lower Kings River since 1978. Dozens of other local, state, and federal agencies have relationships and potential roles in developing the IRWMP (Table 2-9). The Forum was established with the goal of assisting local entities to better manage water supplies and identify water related issues and opportunities.

The Forum has initiated several land and water use surveys as well as conducted comprehensive monitoring and modeling of the Lower Kings River area. The Forum's study area encompasses those portions of Kings, Tulare, and Fresno Counties, that surround the Lower Kings River as it flows southwest from Pine Flat Reservoir. According to the Land Use study conducted by the Forum, the surrounding land use is mostly dedicated to vineyards, fruits, nuts, and field crops (Figure 2-4). The Water Forum has synthesized monitoring data from USGS, the Central Valley Regional Water Quality Control Board, the Kings River Conservation District, the U.S. Army Corps of Engineers, the Southern San Joaquin Valley Water Quality Coalition, and the U.S. Bureau of Reclamation from 1951 to 2006 to assess source water quality issues such as suspended sediments, metals, trace elements, pesticides, nutrients, pathogens, and toxicity in the Lower Kings River. The Kings Groundwater Basin Integrated Ground and Surface Water Model was developed to further understand the Kings groundwater basin as well as analyze the region-wide effects of several water management strategies and several projects involving the surface and groundwater in the area.

Table 2-9: Local, State and Federal Agencies with Roles Relating to Water Management Strategies in the Upper Kings River Basin[25]
Local
Special Districts
Alta Irrigation District
Consolidated Irrigation District
Fresno Irrigation District
Kings River Conservation District
Fresno Metropolitan Flood Control District
Water Associations
Kings River Water Association
Friant Water Users
Community Services Districts
Counties (Fresno, Kings, Tulare)
Public Works
Planning
Health / Environmental Health
Cooperative Extension
Agricultural Commissioner
Cities
Clovis
Fresno
Fowler
Kerman
Kingsburg
Parlier
Reedley
Sanger
Selma
Dinuba
Other Regional
Selma Kingsburg Fowler Regional Sanitary District
State
Department of Water Resources
Regional Water Quality Control Board
State Water Resources Control Board
Department of Fish and Game
Department of Health Services
Department of Food and Agriculture
Department of Pesticide Regulation
Department of Toxics Substances Control
Federal
EPA
Corps of Engineers
Bureau of Reclamation
Fish and Wildlife Service, National Oceanic and Atmospheric Administration
Department of Agriculture Natural Resource Conservation Service

Figure 2-4: Current Land Use in the Water Forum Study Area of Kings, Tulare and Fresno Counties



Source: Upper Kings River Basin Water Forum. White Paper No. 1: Summary of Land Use and Water Use. September 2004

Table 2-10 summarizes other local, regional, state and federal programs and coalitions striving to conserve and improve the water resources of the region.

Table 2-10: Initiatives and Studies

Organization	Initiative/ Study Name	Description / Findings
USGS	National Water Quality Assessment Program 1991-2001[26]	▪ San Joaquin-Tulare Basin Study Area. ▪ Studies primarily concentrated in areas closest to the Sacramento-San Joaquin Delta. ▪ Virtually no surface water sampling conducted in the Lower Kings River region of the basin. ▪ Land-use studies conducted to assess effects of three agricultural land uses on the quality of shallow groundwater. Samples obtained from domestic wells in the following three land uses: vineyards, almond orchards, and corn-alfalfa-vegetables rotations during 1993-1995. ▪ Results indicate that nitrate concentrations were significantly higher in the almond land-use setting, reflecting the relatively high rate of nitrogen application associated with the land-use. More than 20 different pesticides were detected in 68% of the well samples, most of which were concentrated in vineyards. All but one were below the state and federal contaminant levels; the one that exceeded the level was 1, 2-dibromo-3-chloropropane, a fumigant banned in the 1970s but still persistent at high concentrations. ▪ Other investigations taken up include the Low Intensity Phase Sampling study and a Flow Path study assessing the occurrence of nutrients, pesticides, and volatile organic compounds in the aforementioned land-use settings to estimate date of recharge.
	National Water Quality Assessment Program 2001-2011	▪ The second cycle of the program, 2001-2011, is scheduled to repeat the 1991-2001 land use study for the same three land-use settings.
California Water Resource Control Board	Surface Water Ambient Monitoring Program[27]	▪ Goal is to assess baseline conditions of surface water and determine whether any impairment exists to beneficial use. ▪ Currently the program is concentrating on the Upper Kings River and the Pine Flat Reservoir, but it proposes to integrate with other monitoring activities to improve coordination within the region. ▪ Due to current funding limitations, the program is implemented in smaller project-oriented areas in the region to support project-specific decisions.
University of California Davis and Regional Water Quality Control Board	Investigation of Water Quality in Agricultural Drains of Central Valley[28]	▪ Study plan developed to evaluate water quality via aquatic species toxicity testing in agricultural drains in the San Joaquin and Sacramento River watersheds. The study seeks to identify causes and sources of impairments and recommend water quality study designs. ▪ Though not extensive enough for a regional analysis, the results of this study will provide the only water quality data for agricultural drains in the Kings River region.
University of California Davis, U.S. Department of Agriculture Natural Resource Conservation Service	Ranch Quality Planning Short Courses[29]	▪ Courses teach ranchers about non-point source pollution and help them develop water quality plans for their properties. ▪ More than 800 ranchers attended this course between 1997 and 2004, developing water quality plans for more than 1.5 million acres of rangeland. ▪ Recent survey indicates that between 2002 and 2003, two-thirds of those in attendance went on to implement best management practices to address pollution sources identified in their water quality plans.
Kings River Conservation District	AgLine[30]	▪ Provides information on crop water use, run time for micro irrigation systems, and the powdery mildew index.
	On-Farm Water Management[31]	▪ Assists farmers with finding the most efficient and cost-effective use of water. Growers can schedule an appointment for a member of the Kings River Conservation District staff to visit the location to review current irrigation practices.

Table 2-10: Initiatives and Studies

Organization	Initiative/ Study Name	Description / Findings
Kings River Water Association & Kings River Conservation District	Kings River Fisheries Management Program[32]	▪ The purpose of this program is to enhance the broad range of fish and wildlife resources of the Kings River and Pine Flat Reservoir, while protecting the established water rights held by Kings River water users. ▪ Enhancement projects are implemented to benefit fish populations while helping to meet the desires of recreationists on Pine Flat Reservoir and the river.
Kaweah and St. Johns Rivers Association, Kaweah-Delta Water, Navalencia Resource, and Kings River Conservation Districts, Kern County Water Agency, Kings River Water Association, Tule River Association	Southern San Joaquin Water Quality Coalition[33]	▪ Coalition formed in 2002, serving the Tulare Lake Basin watershed from the San Joaquin River south to the Tehachapi Mountains. ▪ The Coalition's mission is to protect and preserve the quality of water supplies and associated water rights of the members and those they serve.
Central Valley Regional Water Quality Control Board	Irrigated Lands Conditional Waiver Program[34]	▪ In July 2003, the Regional Board adopted a new set of regulations pertaining to discharges of waste from irrigated agricultural lands into waters of the State. The regulations, referred to as the Irrigated Lands Conditional Waiver Program, provide an individual irrigator two options: 1) Join a coalition group that will meet the requirements of the program for a group of individuals within a watershed 2) File a Notice of Intent with the Regional Board to participate directly in the program as an individual
U.S. Department of Agriculture Natural Resource Conservation Service	National Resource Inventory. Tech. Publication[35]	▪ A water quality assessment for the Tulare-Buena Vista Lakes Watershed stated that almost one million acres exist where the potential runoff concentration at the edge of the field exceeds one or more water quality thresholds for fish and for humans.
	California's Wetlands Reserve Program	▪ Program focus is on the restoration of a variety of wetland types throughout the state, including seasonal wetlands, semi-permanent marsh, vernal pools along the perimeter of the Central Valley, riparian corridors, and tidally-influenced wetlands.
San Joaquin River Restoration Program	San Joaquin River Restoration Settlement Initiative	▪ The main mission of the initiative is to support and ensure the implementation of the settlement reached after an 18-year law suit to provide sufficient fish habitat in the San Joaquin River below Friant Dam near Fresno. The settlement is based on the following two goals: 1) Restoration: To restore and maintain fish populations in "good condition" in the main stem of the San Joaquin River below Friant Dam to the confluence of the Merced River, including naturally reproducing and self-sustaining populations of salmon and other fish. 2) Water Management: To reduce or avoid adverse water supply impacts to all of the Friant Division long-term contractors that may result from the interim flows and restoration flows provided for in the settlement.

Table 2-10: Initiatives and Studies

Organization	Initiative/ Study Name	Description / Findings
California Environmental Protection Agency	Central Valley Salinity Alternatives for Long-Term Sustainability	▪ The organization is a collaborative basin planning effort aimed at developing and implementing a comprehensive salinity and nitrate management program. ▪ The policy group consists of several committees, including the Executive, Technical Advisory, Social and Economic Impact, and Public Education and Outreach Committees, whose goal is to address all aspects of the initiative with a multifaceted approach.
Westlands Water District		▪ The mission of this organization is to provide a timely, reliable, and affordable water supply to its landowners and water users, and to provide drainage service to those lands that need it. ▪ It actively engages in educational activities to increase awareness of water issues and foster relationships with the schools and organizations in the District. The organization works with federal, state and local agencies to find an environmentally sound and economically feasible method to manage drainage water. ▪ The organization publishes annual water supply, drainage, and crop acreage reports.

Wisconsin and Minnesota River Watersheds

Wisconsin and Minnesota River Watersheds Summary	
Area	• ~ Wisconsin: 7.6 million acres; Minnesota:10.7 million acres
Location	• Wisconsin and Minnesota, part of the Upper Mississippi watershed
Population	• 4.7 million in 2007
Land Use	• ~65% land in farms
Agriculture	• ~ 19% of farmland is dedicated to crops • Corn and soybean harvesting dominate the crop production • Broiler chicken, hog and pig production, and dairy dominate the livestock industry
Food Manufacturing	• 119 federally regulated food manufacturing facilities • Most common industries include cheese manufacturing and animal feed and feed ingredients manufacturing • Large federally regulated corporations include Kraft Foods, Cargill, Seneca Foods Corporation, Archer Daniels Midland, and General Mills
Municipalities	• Watershed has 195 federally-regulated wastewater treatment facilities with 30 holding "major" designations under the National Pollutant Discharge Elimination System
Impairments and Concerns	• Top causes of impairment include mercury, nutrient enrichment, turbidity, and PCBs. • The Wisconsin and Minnesota River Watersheds have 410 waterbodies listed on the Threatened and Impaired Waters lists (303(d)) • Top sources of impairment include atmospheric depositions, non-point sources, and agriculture
Studies and Initiatives	• Minnesota Pollution Control Agency: Surface Water Quality Monitoring • Upper Mississippi River Basin Association Ecosystem Restoration: Environmental Management Program, and Navigation and Ecosystem Study Program. • USGS National Water Quality Assessment Upper Mississippi River Study Unit

Introduction

The Mississippi River Basin, which is the third largest in the world, drains 41 percent of the continental United States and discharges its waters into the Gulf of Mexico.[40] Of the 768,000,000 acres of the Mississippi River Basin, the Upper Mississippi River subbasin encompasses 121,024,000 acres. The Upper Mississippi River Basin is divided into 133 watersheds and is defined as the area that drains to the Mississippi River above of the mouth of the Ohio River.[41] This report will concentrate on the Wisconsin and Minnesota River watersheds of the Upper Mississippi Basin, which together encompass 18 watersheds at the 8-digit hydrologic unit code (HUC) level (Table 3-1). Together these watersheds encompass a total of 18,368,000 acres and include major portions of 24 counties in Wisconsin and 39 counties in Minnesota. The watersheds also include portions of counties in Iowa, Michigan, North Dakota, and South Dakota.[42]

Table 3-1: Area and HUCs of the Wisconsin and Minnesota Watersheds

HUC	Watershed Name	Area (acres)
0707	**Wisconsin River Watershed**	
07070001	Upper Wisconsin	1,401,600
07070002	Lake Dubay	1,721,600
07070003	Castle Rock	2,080,000
07070004	Baraboo	422,400
07070005	Lower Wisconsin	1,510,400
07070006	Kickapoo	481,920
0702	**Minnesota River Watershed**	
07020001	Upper Minnesota	1,267,200
07020002	Pomme de Terre	576,640
07020003	Lac Qui Parle	684,800
07020004	Hawk-Yellow Medicine	1,305,600
07020005	Chippewa	1,324,800
07020006	Redwood	457,600
07020007	Middle Minnesota	870,400
07020008	Cottonwood	825,600
07020009	Blue Earth	1,004,800
07020010	Watonwan	534,400
07020011	Le Sueur	710,400
07020012	Lower Minnesota	1,158,400

Note on Watersheds, Subwatersheds, Basins and Subbasins

The state of Wisconsin delineates its watersheds differently from the system used by the Federal government. The Wisconsin Department of Natural Resources utilizes a four-tiered classification system in which the state is divided into three major river basins, with each one further divided into 24 Water Management Units, which are approximately at the 8-digit hydrologic unit code (HUC) level. The third tier of the classification system is called Geographic Management Units, which are primarily used to define work boundaries of Wisconsin Department of Natural Resources employees and incorporate both the county boundaries, and to some extent, the 8-digit HUC level boundaries. The fourth tier is the Watershed unit, which is used primarily for management at the local level and is approximately at the 10-digit HUC level. The Mississippi River Basin is the largest in the state, and the Wisconsin River watershed makes up a large part of that basin.[36]

The state of Minnesota delineates its watersheds similarly to the system used by the federal government with 8 major basins and 81 major watersheds.[37] The Minnesota River Basin Data Center, established with a Legislative grant and other contributions, defines the Minnesota River Basin as the USGS does with 12 major watersheds at the 8-digit HUC level, which are made up of the 1,183 minor watersheds in the basin.[38] The Minnesota River Basin is also divided into 13 management watersheds, which in comparison to the 8-digit HUC level, makes a differentiation between Hawk and Yellow Medicine watersheds.[39] In compiling data for this report, county, state, and federal data are utilized and differences in geographic scope are noted.

Agriculture

The Minnesota and Wisconsin River watersheds are important agricultural areas with much of their land use in production (Table 3-2). Over 60 percent of the Upper Mississippi Watershed is devoted to cropland or pasture, 23 percent of the land is forested, 7 percent is wetlands, 5 percent is covered by water, and another 5 percent is urban and suburban.[43] In the Minnesota River Watershed, agriculture accounts for more than 92 percent of the land use.[44] The top crops produced in the area are corn, soybeans, forage, wheat, vegetables, and sugarbeets. Livestock production also plays an important role in both watersheds. The Wisconsin River watershed has a large dairy industry, and the Minnesota River watershed has significant broiler and hog and pig production (Table 3-3).[45]

Table 3-2: Upper Mississippi Region Land Use (2002)

Total Area of Mississippi River Basin (acres)	768,000,000
Total Area of Upper Mississippi River Watershed (acres)	121,024,000
Total Area of Minnesota and Wisconsin Watershed (acres)	18,368,000
Total County Area[a] (acres)	35,869,440
Land in Farms (acres)	23,309,568
Land in Farms as Percent of Total County Area	65%
Cropland (acres)	4,334,047
Cropland as Percent of Land in Farms	19%
Irrigated Land (acres)	541,279
Irrigated Land as Percent of Total County Area	1.5%

[a] Includes total area of HUCs 0707 (The Wisconsin River Watershed) and 0702 (Minnesota River Watershed).
Source: 2002 Census of Agriculture (U.S. Department of Agriculture). Wisconsin, Minnesota, Iowa, Michigan and South Dakota County Level Data.

Table 3-3: Harvested Crops and Livestock Inventory for Counties[a] of the Wisconsin and Minnesota River Watersheds (2002)			
	Wisconsin River Watershed	**Minnesota River Watershed**	**Total****
Crops Harvested (acres)			
Barley for Grain	14,312	23,922	**38,234**
Corn for Grain	1,121,648	5,402,082	**6,523,730**
Corn for Silage	251,610	212,766	**464,376**
Dry Edible Beans	-	43,185	**43,185**
Forage	1,284,889	867,595	**2,152,484**
Land in Orchards	2,307	1,252	**3,559**
Oats for Grain	105,477	112,747	**218,224**
Potatoes	68,515	12,449	**80,964**
Sorghum for Grain	-	56	**56**
Sorghum for Silage	674	1,351	**2,025**
Soybeans for Beans	519,720	5,413,304	**5,933,024**
Sugarbeets for sugar	-	131,738	**131,738**
Sunflower Seeds	427	1,820	**2,247**
Sweet Potatoes	-	-	**-**
Vegetables	118,346	149,093	**267,439**
Wheat for Grain	28,467	6,416	**34,883**
Livestock Inventory (number)			
Beef Cows	126,407	229,034	**355,441**
Broilers	249,873	11,006,188	**11,256,061**
Hogs and Pigs	429,718	5,638,296	**6,068,014**
Layers	541,200	1,063,911	**1,605,111**
Milk Cows	479,043	244,384	**723,427**
Sheep and Lamb	36,354	120,011	**156,365**

Source: 2002 Census of Agriculture (U.S. Department of Agriculture).
[a] Includes total area of HUCs 0707 (The Wisconsin River Watershed) and 0702 (Minnesota River Watershed).
** The Wisconsin and Minnesota watersheds encompass portions of 74 counties in 6 States. Because the watershed boundaries differ from county boundaries, the data presented here actually represent a larger area than the watershed.

Food Manufacturing

EPA's data systems show 119 federally regulated food processing facilities in the Wisconsin and Minnesota River watersheds, with 42 and 77 in each, respectively (Figures 3-1 and 3-2). The dominant industry in the Wisconsin River watershed is Natural, Processed, and Imitation Cheese (SIC# 2022), with 40 percent of the watershed's facilities operating within the industry. The Minnesota River watershed has a relatively large Prepared Feed and Feed Ingredients for Animals and Fowls, Except Dogs and Cats Industry (SIC# 2048), with one third of the facilities manufacturing its products (Table 3-4).

Figure 3-1: Federally Regulated Food Manufacturing Facilities in the Wisconsin River Watershed

Source: Data generated from EPA's Integrated Data for Enforcement Analysis (IDEA) system for Food and Kindred Products Manufacturing, July 2008. Federal permits and identifiers considered include NPDES permits, Clean Air Act air permits, Resource Conservation and Recovery Act hazardous waste IDs, and Toxic Release Inventory reporters between 2004 and 2006.

Figure 3-2: Federally Regulated Food Manufacturing Facilities in the Minnesota River Watershed

Source: Data generated from EPA's IDEA system for Food and Kindred Products Manufacturing, July 2008. Federal permits and identifiers considered include NPDES permits, Clean Air Act air permits, Resource Conservation and Recovery Act hazardous waste IDs, and Toxic Release Inventory reporters between 2004 and 2006.

Table 3-4: Federally Regulated Food Product Facilities in the Wisconsin and Minnesota River Watersheds

SIC Code	Industry Description	Number of Facilities	
		Wisconsin River Watershed	Minnesota River Watershed
2011	Meat Packing Plants	1	1
2013	Sausages and Other Prepared Meats		2
2015	Poultry Slaughtering and Processing		6
2021	Creamery Butter	2	1
2022	Natural, Processed, and Imitation Cheese	17	6
2023	Dry, Condensed, and Evaporated Dairy Products	6	2
2024	Ice Cream and Frozen Desserts		1
2026	Fluid Milk	1	
2033	Canned Fruits, Vegetables, Preserves, Jams, and Jellies	5	5
2034	Dried and Dehydrated Fruits, Vegetables, and Soup Mixes	2	1
2037	Frozen Fruits, Fruit Juices, and Vegetables	1	1
2038	Frozen Specialties, NEC		1
2041	Flour and Other Grain Mill Products		3
2046	Wet Corn Milling	1	1
2047	Dog and Cat Food	1	1
2048	Prepared Feed and Feed Ingredients for Animals and Fowls, Except Dogs and Cats	4	28
2053	Frozen Bakery Products, Except Bread		1
2063	Beet Sugar		2
2075	Soybean Oil Mills		4
2077	Animal and Marine Fats and Oils		2
2083	Malt		1
2086	Bottled and Canned Soft Drinks and Carbonated Waters		5
2087	Flavoring Extracts and Flavoring Syrups NEC		1
2099	Food Preparations, NEC	1	1

Source: Data generated from EPA's IDEA system for Food and Kindred Products Manufacturing, July 2008. Federal permits and identifiers considered include NPDES permits, Clean Air Act air permits, Resource Conservation and Recovery Act hazardous waste IDs, and Toxic Release Inventory reporters between 2004 and 2006.

The Wisconsin River watershed harbors several large food manufacturing companies (Table 3-5). The watershed's natural, processed, and imitation cheese industry is dominated by Foremost Farms USA, Mullins Cheese Inc., and Kraft Foods, Inc. Other prominent companies in the watershed include Land O'Lakes in the prepared feeds and feed ingredients industry, and Chiquita Process Foods and Del Monte Foods in the canned fruits and vegetables industry.

The Minnesota River watershed also has a number of large food manufacturing companies, some of the most prominent of which are listed in Table 3-6. Other large companies located in the watershed include the Pepsi Bottling Group, Archer Daniels Midland, Land O'Lakes, and General Mills. However, many smaller food processing facilities either do not discharge pollutants into waters of the United States and thus do not have NPDES permits or they are "minor" dischargers and are not reported to the federal level. Thus, the data do not

include the entire population of food processors in the watershed. In fact, the county-level Census of Manufacturers data for 2002 shows more than 550 establishments in the food manufacturing sector in the counties of the Wisconsin and Minnesota River watersheds (Table 3-7).[††] [46]

Table 3-5: Top Federally Regulated Companies in the Wisconsin River Watershed

SIC Code: Industry Description	
Company Name	**Number of Federally Regulated Facilities**
2022: Natural, Processed, and Imitation Cheese	
Foremost Farms USA	4
Mullins Cheese Inc	3
Kraft Foods, Inc.	2
2023: Dry, Condensed and Evaporated Dairy Products	
Foremost Farms USA	2
2048: Prepared Feeds and Feed Ingredients for Animals and Fowls, Except Dogs and Cats	
Land O'Lakes Incorporated	2

Source: Data generated from EPA's IDEA system for Food and Kindred Products Manufacturing, July 2008. Federal permits and identifiers considered include NPDES permits, Clean Air Act air permits, Resource Conservation and Recovery Act hazardous waste IDs, and Toxic Release Inventory reporters between 2004 and 2006.
Note: Only those companies with 2 or more facilities are shown.

Table 3-6: Top Federally Regulated Companies in the Minnesota River Watershed

SIC Code: Industry Description	
Company Name	**Number of Federally Regulated Facilities**
2015: Poultry Slaughtering and Processing	
Jennie-O Foods Incorporated	3
M G Waldbaum Company	2
2022:Natural, Processed, and Imitation Cheese	
Valley Queen Cheese Inc.	2
2033: Canned Fruits, Vegetables, Preserves, Jams, and Jellies	
Seneca Foods Corp.	3
2048: Prepared Feeds and Feed Ingredients for Animals and Fowls, Except Dogs and Cats	
Cargill	2
Quali Tech Incorporated	2
Farm Service Elevator Company	2
2086: Bottled and Canned Soft Drinks and Carbonated Water	
Coca Cola	2

Source: Data generated from EPA's IDEA system for Food and Kindred Products Manufacturing, July 2008. Federal permits and identifiers considered include NPDES permits, Clean Air Act air permits, Resource Conservation and Recovery Act hazardous waste IDs, and Toxic Release Inventory reporters between 2004 and 2006.
Note: Only those companies with 2 or more facilities are shown.

[††] Not all counties in the Wisconsin and Minnesota watersheds are included in the Census data. Of the 74 counties in the Wisconsin and Minnesota watersheds, 18 counties had no data for manufacturing (North American Industry Classification System codes 30 and 31). Out of the 57 counties that had data, only 8 in the Wisconsin River watershed and 17 in the Minnesota River watershed returned results for food manufacturing (North American Industry Classification System code 311).

Table 3-7: Number of Food Manufacturing Establishments in the Counties of the Wisconsin and Minnesota River Watershed

County	Number of Establishments
Wisconsin River Watershed	
Clark County, WI	22
Columbia County, WI	18
Dane County, WI	62
Marathon County, WI	25
Monroe County, WI	7
Portage County, WI	12
Taylor County, WI	7
Wood County, WI	22
Minnesota River Watershed	
Blue Earth County, MN	14
Brown County, MN	8
Carver County, MN	20
Dakota County, MN	45
Faribault County, MN	6
Freeborn County, MN	8
Hennepin County, MN	124
Kandiyohi County, MN	11
Le Sueur County, MN	8
Lyon County, MN	7
McLeod County, MN	10
Otter Tail County, MN	15
Ramsey County, MN	46
Rice County, MN	15
Sibley County, MN	4
Stearns County, MN	33
Watonwan County, MN	6

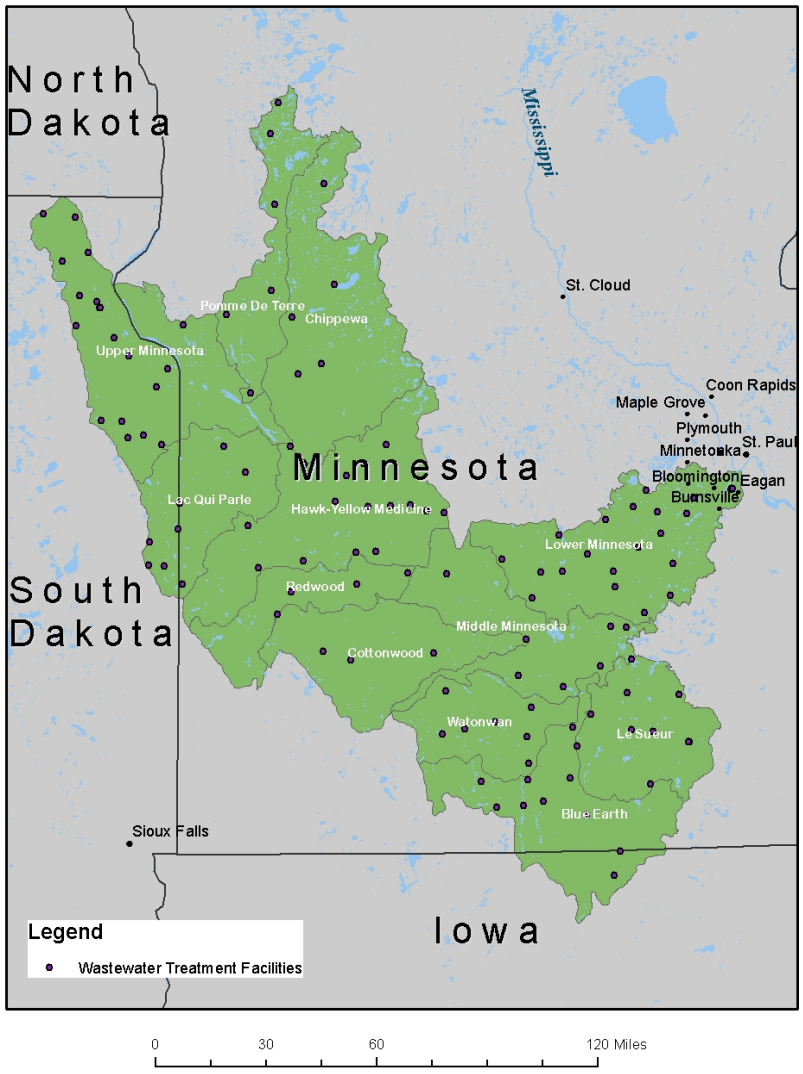
Source: U.S. Census Bureau. 2002 Economic Census of Manufacturing. County Profiles.

Municipalities

The Upper Mississippi River Basin has a population of more than 30 million people and almost 80 percent live in urban areas. In 2007, the 74 counties that make up the Wisconsin and Minnesota River Watersheds had a population of 4.7 million people, with a population change of about 4% since the year 2000.[47] Population densities vary by county. For example, Ramsey and Hennepin Counties in Minnesota are very densely populated, while other large areas of the watershed, such as Marshall County in South Dakota and Traverse County in

Minnesota, are sparsely populated.[‡‡] According to EPA's data systems, there are 195 wastewater treatment plants with National Pollutant Discharge Elimination System (NPDES) Permits in the Wisconsin and Minnesota Watersheds. Of these 195 facilities, 30 hold 'major' NPDES designations[§§] (Figures 3-3 and 3-4, Table 3-8).

Figure 3-3: Wastewater Treatment Facilities in the Minnesota River Basin

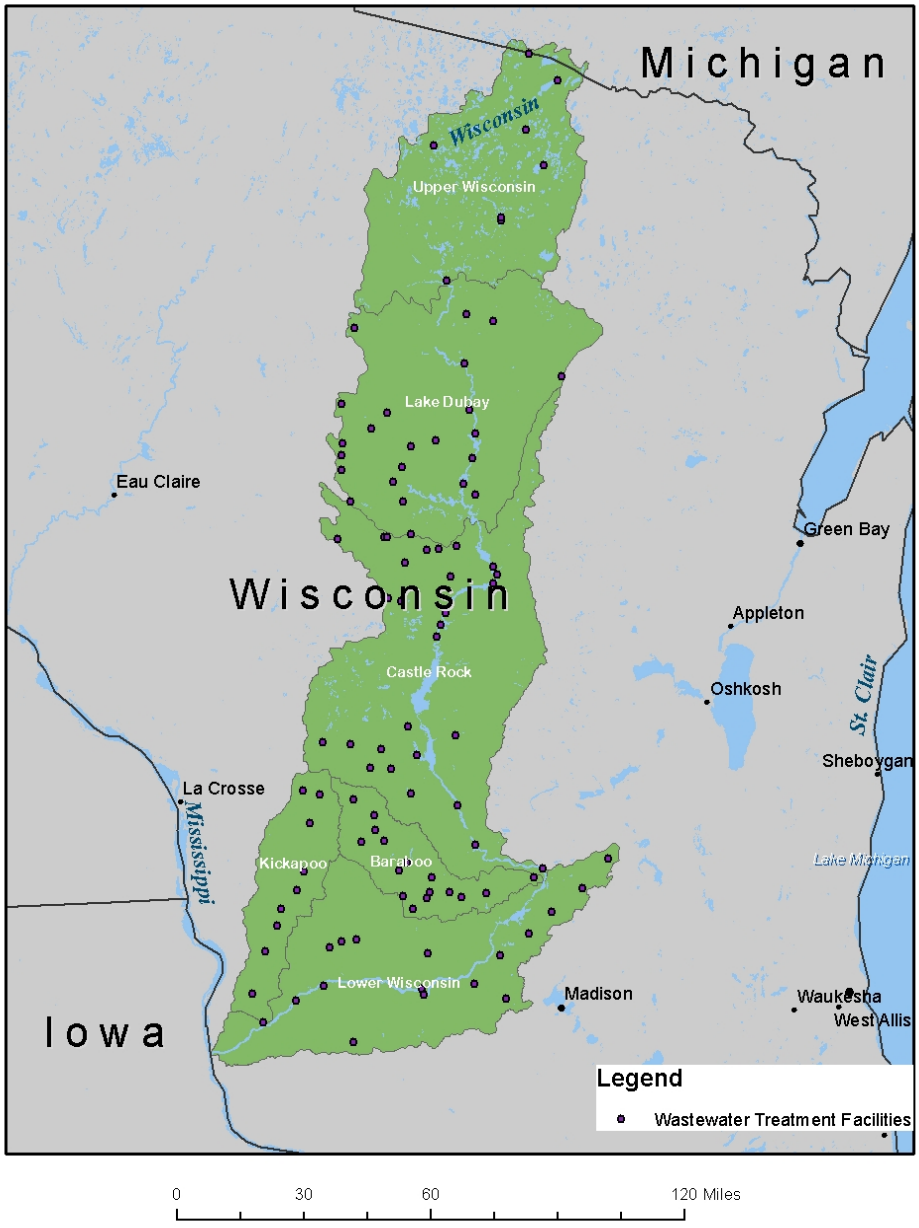


Source: Data generated from EPA's IDEA system for Wastewater Treatment Facilities, July 2008. Federal permits and identifiers considered include NPDES permits, Clean Air Act air permits, Resource Conservation and Recovery Act hazardous waste IDs, and Toxic Release Inventory) reporters between 2004 and 2006.

[‡‡] The Wisconsin and Minnesota watersheds encompass portions of 44 counties in Wisconsin, Minnesota, Iowa, Michigan and South Dakota. Because the watershed boundaries differ from county boundaries, the data presented here actually represent a larger area than the watershed.

[§§] Each NPDES permit holder is defined by the program office as a Major or Minor discharger. Classification as a major discharger generally involves factors relating to the significance of the discharger's impact on the environment, such as nature and quantity of pollutants discharged, character and assimilative capacity of the receiving waters, presence of toxic pollutants in the discharge, and discharger's compliance history.

Figure 3-4: Wastewater Treatment Facilities in the Wisconsin River Basin



Source: Data generated from EPA's IDEA system for Wastewater Treatment Facilities, July 2008. Federal permits and identifiers considered include NPDES permits, Clean Air Act air permits, Resource Conservation and Recovery Act hazardous waste IDs, and Toxic Release Inventory) reporters between 2004 and 2006.

Table 3-8: Municipal Wastewater Treatment Facilities in the Wisconsin and Minnesota River Watersheds

Watersheds	Sub-Watersheds	Number of Facilities	Number of NPDES Major Water Permits
Wisconsin River Watershed	Upper Wisconsin	8	1
	Lake Dubay	23	4
	Castle Rock	28	7
	Baraboo	2	2
	Lower Wisconsin	1	1
	Kickapoo	10	0
Minnesota River Watershed	Upper Minnesota	21	2
	Pomme De Terre	6	0
	Lac Qui Parle	8	0
	Hawk-Yellow Medicine	15	0
	Chippewa	7	1
	Redwood	4	1
	Middle Minnesota	7	2
	Cottonwood	5	1
	Blue Earth	10	2
	Watonwan	7	2
	Le Sueur	10	1
	Lower Minnesota	23	3

Source: Data obtained from EPA's IDEA system on July 8, 2008. Query criteria include the following federal permits and identifiers: NPDES permits, Clean Air Act air permits, Resource Conservation and Recovery Act hazardous waste IDs, and Toxic Release Inventory) reporters between 2004 and 2006.

Impairments and Concerns***

The Mississippi River Basin delivers an average of 580 km^3 of fresh water to the Gulf of Mexico each year. More than half of the Basin is cropland, and runoff carries sediment, pesticides, and fertilizer into the Mississippi River and to the Gulf of Mexico. Each year the river carries to the Gulf more than 210 million tons of sediment, 1.6 million tons of nitrate, and 100,000 tons of phosphorus. This nutrient over-enrichment has caused large areas of oxygen depletion called hypoxia, as well as algal blooms and eutrophication.[48] [49]

The Upper Mississippi is the only waterbody in the nation that has been recognized by Congress as a "nationally significant ecosystem and a nationally significant commercial navigation system."[50] The 2006 Clean Water Act Section 303(d) Threatened and Impaired Waters List for the Wisconsin and Minnesota River watersheds, which lists waterbodies that are impaired or are threatened to be impaired by pollutants, has 410 waters listed as impaired.

Of the common causes of impairment, mercury is the most common cause with half of the sub-basins of the Wisconsin River watershed impaired. Sediment and degraded habitat were the next most common causes for the other half of the sub-watersheds.

*** The impairments cited here represent the monitoring activities taking place in the watershed and may not reflect the complete condition of the watershed.

The Minnesota River is considered one of the most polluted rivers in Minnesota and the country.[51] The most frequently reported impairment in the Minnesota River watershed was a Fish Consumption Advisory (FCA) due to mercury, with all but three sub-watersheds reporting it as the top impairment. Cottonwood, Watonwan, and Le Sueur reported turbidity as the most frequent cause of impairment (Tables 3-9 and 3-10).

Table 3-9: Common Causes of 303(d) Impairment for the Wisconsin River Watershed

Sub-Watersheds	No. of Waterbodies Listed as Impaired	Causes of Impairment	No. of Waterbodies with Causes of Impairment Reported
Upper Wisconsin	57	FCA Mercury	56
		Other Metals	1
		Sediment Oxygen Demand	1
		Aquatic Toxicity	1
		Dissolved Oxygen	1
Lake Dubay	19	FCA Mercury	14
		Dissolved Oxygen	5
		Phosphorus	4
		Aquatic Toxicity	2
		Sediment Oxygen Demand	1
		Other Metals	1
		FCA PCBs	1
		Toxic Substances	1
Castle Rock	11	FCA Mercury	6
		Phosphorus	5
		Dissolved Oxygen	5
		FCA PCBs	3
		pH	2
		Dioxin	2
		Nutrients	1
		Eutrophication	1
		Bacteria	1
		Beach Closures	1
		Biochemical Oxygen Demand	1
Baraboo	4	Sediment	4
		Degraded Habitat	3
		Dissolved Oxygen	2
		Biochemical Oxygen Demand	1
		Nutrients	1
		Phosphorus	1
Lower Wisconsin	14	Degraded Habitat	10
		Sediment	10
		Aquatic Toxicity	2
		FCA Mercury	2
		Temperature	2
		FCA PCBs	2
		Ammonia	1
		Biochemical Oxygen Demand	1
		Dissolved Oxygen	1
Kickapoo	2	Sediment	1
		FCA Mercury	1
		Degraded Habitat	1

Table 3-10: Common Causes of 303(d) Impairment for the Minnesota River Watersheds

Sub-Watersheds	No. of Waterbodies Listed as Impaired	Cause of Impairment	No. of Waterbodies with Cause of Impairment Reported
Upper Minnesota	14	FCA Mercury	8
		Fish Community Rated Poor	2
		Ammonia	1
Pomme de Terre	14	FCA Mercury	14
		Turbidity	1
		Fecal Coliform	1
		Fish Community Rated Poor	1
Lac Qui Parle	12	Fecal Coliform	8
		FCA Mercury	6
		Turbidity	5
		Fish Community Rated Poor	4
		Low Oxygen	2
Hawk-Yellow Medicine	46	FCA Mercury	32
		Turbidity	9
		FCA PCBs	8
		Fecal Coliform	8
		Fish Community Rated Poor	6
		Nutrients	2
Cheppewa	36	FCA Mercury	17
		Fecal Coliform	10
		Nutrients	8
		Turbidity	8
		Fish Community Rated Poor	4
		Low Oxygen	1
Redwood	14	FCA Mercury	12
		Turbidity	5
		Fecal Coliform	4
		Fish Community Rated Poor	4
		Ammonia	1
		Nutrients	1
Middle Minnesota	28	FCA Mercury	19
		FCA PCBs	15
		Turbidity	11
		Fecal Coliform	6
		Fish Community Rated Poor	3
		PCBs	2
		Mercury	2
		Nutrients	1
Cottonwood	15	FCA Mercury	9
		Turbidity	7
		Fecal Coliform	6

Table 3-10: Common Causes of 303(d) Impairment for the Minnesota River Watersheds

Sub-Watersheds	No. of Waterbodies Listed as Impaired	Cause of Impairment	No. of Waterbodies with Cause of Impairment Reported
		Fish Community Rated Poor	3
		Nutrients	1
Blue Earth	29	FCA Mercury	12
		Turbidity	12
		Fecal Coliform	11
		Fish Community Rated Poor	6
		Nutrients	5
		Impaired Biotic Communities	3
		Mercury	2
		Low Oxygen	2
		Ammonia	1
		FCA PCBs	1
Watonwan	13	Turbidity	9
		Fecal Coliform	5
		Fish Community Rated Poor	4
		FCA Mercury	2
		Mercury	1
Le Sueur	8	Turbidity	3
		Mercury	3
		FCA Mercury	3
		Fish Community Rated Poor	3
		PCBs	2
		Fecal Coliform	1
		Nutrients	1
Lower Minnesota	74	FCA Mercury	33
		Nutrients	30
		Fecal Coliform	20
		Turbidity	16
		FCA PCBs	9
		Fish Community Rated Poor	7
		Mercury	5
		Chloride	2
		Low Oxygen	1

The Wisconsin and Minnesota 2006 Clean Water Act Section 305(b) National Water Quality Inventory Reports, which disclose conditions of all assessed waterbodies in the state including causes of impairment from types of pollution and likely sources of pollution, have more than 700 waterbodies in the Wisconsin and Minnesota River Watersheds listed as "impaired" (Table 3-11). As a percentage of the total waters in the watersheds, the majority of the Minnesota River watershed has not been assessed, whereas most of the Wisconsin River watershed has been assessed (Table 3-12).

Table 3-11: Wisconsin and Minnesota River Watersheds 305(b) List of Impaired Waters Summary (2006)

HUC	Watershed Name	Impaired	Threatened	Good	Total
0702	Minnesota River Watershed	283	0	96	379
0707	Wisconsin River Watershed	435	1	426	862

Table 3-12: Wisconsin and Minnesota River Watersheds Percent of Total Waters Assessed under 305(b) (2006)

HUC	Watershed Name	Not assessed	%	Assessed	%	Total
0702	Minnesota River Watershed	1,529	80	379	20	1,908
0707	Wisconsin River Watershed	625	42	862	58	1,487

According to the Wisconsin 305(b) National Water Quality Inventory Reports, contaminated fish tissue is the top cause of impairment in each of the sub-watersheds. Atmospheric deposition of toxics, non-point sources, and contaminated sediment are among the top sources of impairment as identified by the state (Table 3-13). According to the report, agricultural activities, such as animal feeding operations and crop production, are identified as some of the key contributing sources of impairment in most of the sub-watersheds of the Wisconsin River watershed.

The Minnesota 305(b) National Water Quality Inventory Report listed mercury in fish tissue, nutrient eutrophication, and turbidity as the main causes of impairment for all 12 of the sub-watersheds of the Minnesota River watershed. Although Minnesota did not report any sources of impairment in their 2006 305(b) report, according to the state's Pollution Control Agency, almost all of the mercury, which is one of the watershed's primary causes of impairment, that contaminates Minnesota's waterbodies originates from human activities such as burning coal, manufacturing, and mining.[52] Other important pollution causes are nutrient enrichment and excessive sediment. According to the Minnesota River Basin Data Center, phosphorus is contributed by both point (e.g. municipal and industrial dischargers) and non-point (e.g. runoff from agricultural lands and urban areas) sources. Nitrate, the dominant form of nitrogen in the watershed, is largely contributed by agricultural drainage, with the Lower Minnesota sub-watershed exhibiting the highest levels of nutrient enrichment.[53]

Table 3-13: 305(b) Top Causes and Sources of Impairment for the Wisconsin River Watershed (2006)	
Sub-Watershed Name	
Top Cause of Impairment	**Top Source of Impairment**
Upper Wisconsin (7070001)	
Contaminated fish tissue	Atmospheric deposition - toxics
Dissolved oxygen	Sediment re-suspension
Lake Dubay (7070002)	
Contaminated fish tissue	Atmospheric deposition - toxics
Ambient bioassays - chronic aquatic toxicity	Contaminated sediments
Castle Rock (7070003)	
Contaminated fish tissue	Atmospheric deposition - toxics
Excess algal growth	Non-point source
Nitrogen, total	Livestock (grazing or feeding operations)
Phosphorus, total	Animal feeding operations
Baraboo (7070004)	
Contaminated fish tissue	Atmospheric deposition - toxics
Non-native fish/shellfish/zooplankton	Non-point source
Lower Wisconsin (7070005)	
Contaminated fish tissue	Atmospheric deposition - toxics
Non-native fish/shellfish/zooplankton	Contaminated sediments
Phosphorus, total	Upstream source
Kickapoo (7070006)	
Contaminated fish tissue	Atmospheric deposition - toxics
Physical substrate habitat alterations	Non-point source
Total coliform	Livestock (grazing or feeding operations)

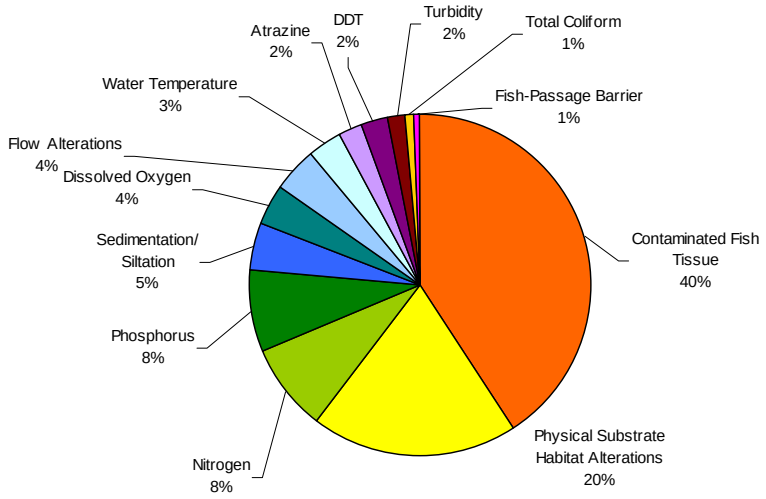
The states of the Upper Mississippi watershed have diverse methods of monitoring water quality and data collection. The State of Wisconsin Department of Natural Resources uses baseline monitoring and other monitoring techniques carried out as part of specific projects. The Wisconsin Department of Natural Resources also has an active fish contaminant monitoring program, which analyzes fish tissue samples for mercury and PCBs.

Minnesota has a somewhat different approach to water quality monitoring. In 1995, the Minnesota Pollution Control Agency adopted a basin concept to water monitoring and organizes monitoring efforts around the ten major drainage basins in the state, two of which are considered part of the Upper Mississippi River Basin. Minnesota focuses its monitoring programs on chemical sampling at fixed stations as well as statistically-based biological monitoring of sites in each of the ten basins. The biological monitoring includes fish, macro-invertebrates, habitat measures, flow, and water chemistry.

The differences between each state's monitoring approach can be seen in Figures 3-6 and 3-7, which present causes of 305(b) waterbodies impairment as a percent of the total miles assessed by state. Wisconsin's impairments reflect its focus on fish tissue analysis whereas Minnesota's reflects its diverse monitoring programs.[54] Because the states employ such different techniques of water quality monitoring, water quality data

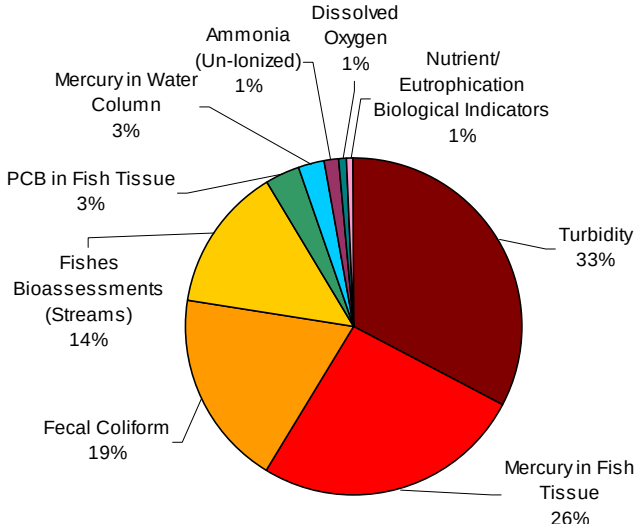
from each state is presented separately and not combined. Out of 1,240 miles of assessed waters with listed causes of impairment, contaminated fish tissue, and physical substrate habitat alterations made up two thirds of the impairments reported in the Wisconsin River Watershed. Turbidity, mercury in fish tissue, and fecal coliform made up three quarters of the impairments reported in the Minnesota River Watershed (Figures 3-6 and 3-7).[55]

Figure 3-6: Causes of 305(b) Waterbodies Impairment of the Wisconsin River Watershed as Percent of Total Miles Assessed



Source: EPA Office of Water website, [http://iaspub.epa.gov/waters10/attains_nation_cy.control?p_report_type=T]

Figure 3-7: Causes of 305(b) Waterbodies Impairment of the Minnesota River Watershed as Percent of Total Miles Assessed



Source: EPA Office of Water website, [http://iaspub.epa.gov/waters10/attains_nation_cy.control?p_report_type=T]

Water Quality Monitoring Stations

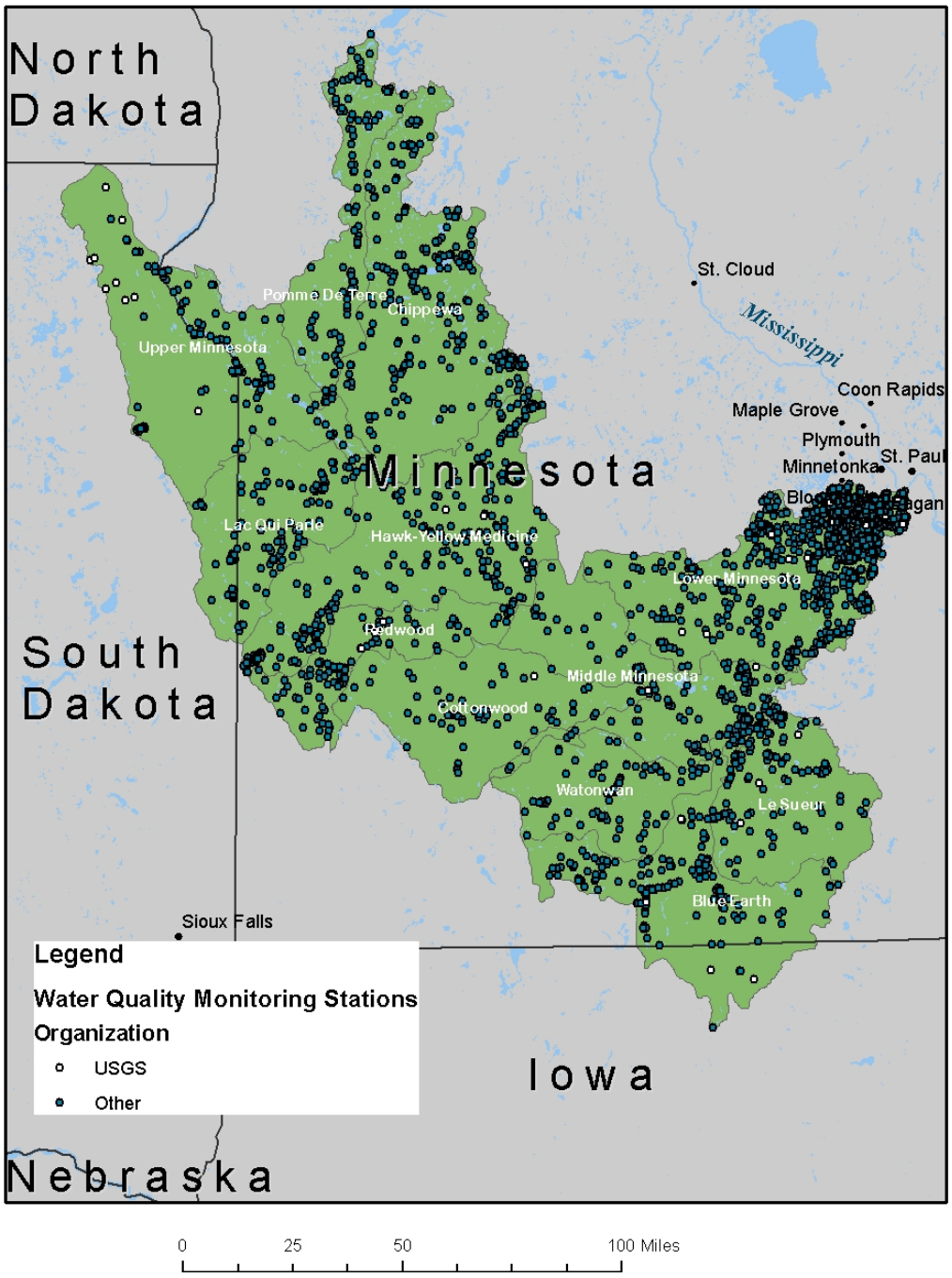
There are a number of organizations that routinely monitor water quality in the 74 counties of the Wisconsin and Minnesota River watersheds. While various organizations focus their monitoring efforts on particular pollutants, most report to EPA's Storage and Retrieval Data Warehouse (STORET). STORET is a data management system containing water quality information for the nation's waters. The organizations that report water quality data to the STORET database are from various state agencies in Wisconsin, Minnesota, Iowa, South Dakota, and Michigan; the Lac du Flambeau Band of Lake Superior Chippewa Indians Department of Natural Resources; the National Park Service; and the National Aquatic Resource Survey (NARS). The U.S. Geological Survey's (USGS) National Water Information System stores water quality data of more than 1.5 million sites throughout the country, and conducts monitoring for the entire spectrum of impairments as well as quantity, distribution, and movement of water parameters. The USGS has 3,250 stations operating in the Wisconsin and Minnesota River watersheds (Table 3-14, Figures 3-8 and 3-9).

Table 3-14: Water Quality Monitoring Stations in the Wisconsin and Minnesota River Watersheds*

Water Monitoring Organizations	Wisconsin River Watershed	Minnesota River Watershed
Minnesota Pollution Control Agency		5,105
Minnesota Pollution Control Agency		1,353
Minnesota Pollution Control Agency Biological Monitoring		75
NARS	12	9
South Dakota Department of Environmental & Natural Resources		14
South Dakota Geological Survey		4
South Dakota Department of Environmental & Natural Resources		108
National Park Service	1	
IOWATER	1	5
Iowa Department of Natural Resources		4
Wisconsin Department of Natural Resources	3,962	
Michigan Department of Environmental Quality	232	
Lac du Flambeau Band of Lake Superior Chippewa Indians Department of Natural Resources	10	
USGS	2,589	661
Total	6,807	7,338

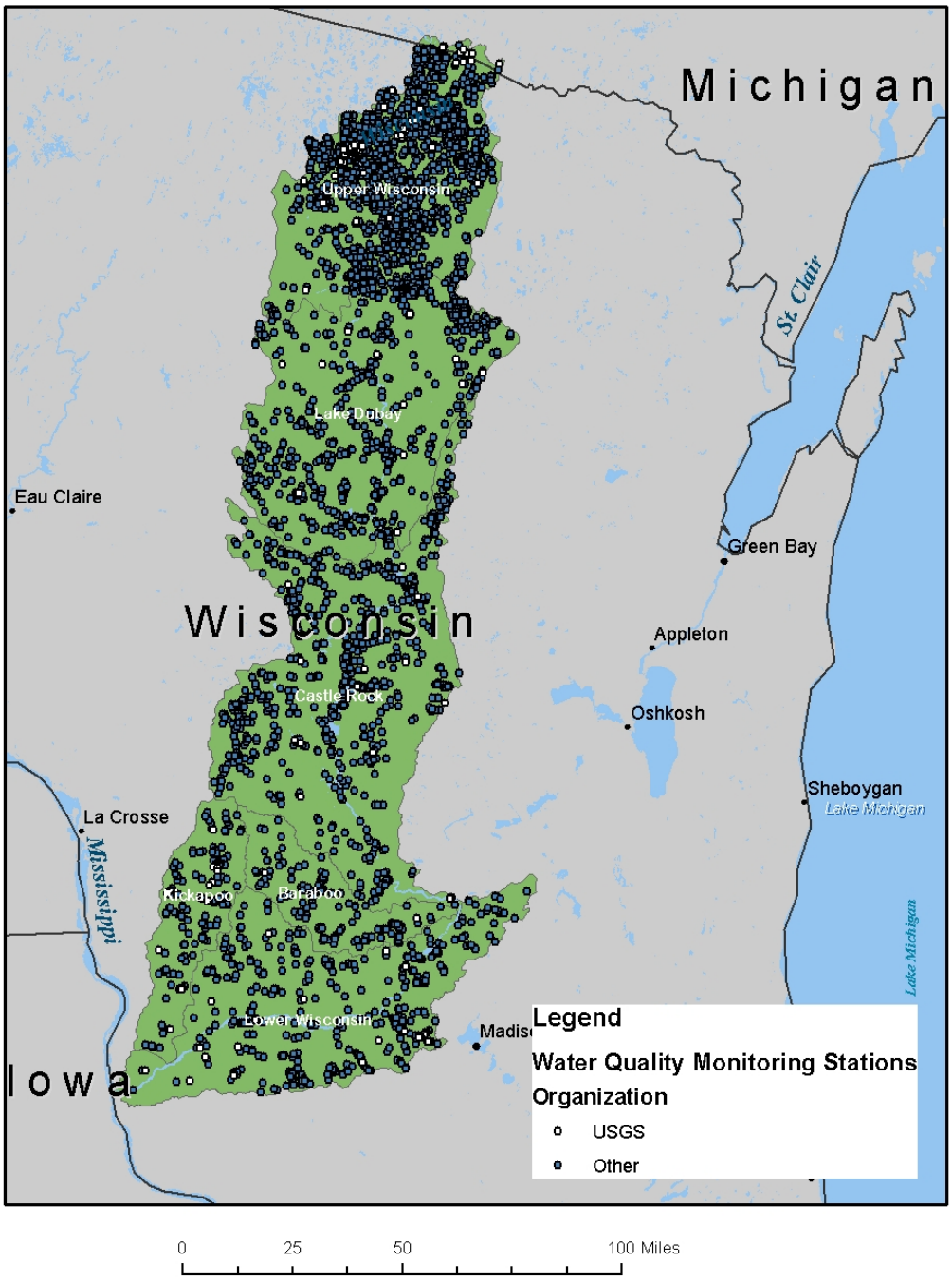
***Monitoring stations active between 2002 to present, with at least one type of water quality parameter tested at the site. Monitoring station data collected from the USGS National Water Information System and EPA's STORET.

Figure 3-8: Water Quality Monitoring Stations in the Minnesota River Watershed



Source: U.S. EPA Storage and Retrieval (STORET) database, USGS National Water Information System database.

Figure 3-9: Water Quality Monitoring Stations in the Wisconsin River Watershed



Source: U.S. EPA Storage and Retrieval (STORET) database, USGS National Water Information System database.

Studies and Initiatives

There are a number of initiatives focusing on the entire Upper Mississippi River Basin. Relatively few focus specifically on the Wisconsin and Minnesota River watersheds.

Since 1994, the National Water Quality Assessment Program has conducted surface and groundwater quality assessments in the Upper Mississippi River Basin, which is one of its 59 "study units." The Upper Mississippi River was selected as a study unit because of its importance as the basin containing the headwaters of the Mississippi River. Studies have shown that forested areas, which make up about 23 percent of the basin, have fewer water quality issues than other areas of the Upper Mississippi. Agricultural areas, which make up the majority of the basin, in contrast have a number of water quality issues such as sedimentation from point and nonpoint sources, nutrients, pesticides, and modifications to the river and removal of riparian vegetation for drainage or channel straightening.[56]

The Upper Mississippi River Basin Association was established in 1981 and is a cooperative effort between state and local government and non-governmental organizations in Illinois, Iowa, Minnesota, Missouri, and Wisconsin on issues of water and land resource management (Table 3-15). There are also six federal agencies that participate in the Upper Mississippi River Basin Association, but are not official members of the association. The association has published a number of water quality documents that highlight the states' approaches to water quality monitoring and characterizing and analyzing impairments of the river basin.[57]

An organization for the Minnesota River watershed that serves as a data source for information concerning the watershed is the Minnesota River Basin Data Center, which was established in 1997. The purpose of the Center's inventory is to describe the status and availability of natural resource data for areas associated with the Minnesota River watershed. It provides links to 90 projects involved with the Minnesota River watershed, reports concerning the watershed and sub-watersheds, as well as geographic information system maps and an inventory of other data.[58]

Studies in Wisconsin primarily focus on fish and aquatic life use for public health concerns such as consumption. For over thirty years Wisconsin has completed a water quality assessment in compliance with Section 305(b) of the Clean Water Act. The most recent report published is for 2006. Wisconsin hopes to expand its assessments in the future and to cover areas that have not yet been studied.[59]

Table 3-16 summarizes some of the major local, regional, state, and federal programs and coalitions striving to conserve and improve the water resources of the region.

Table 3-15: Local, State and Federal Agencies and Organizations Contributing to the Upper Mississippi River Basin
American Water Works Association
Anoka County, Minnesota
Bell Museum of Natural History
Cedar Creek Natural History Area
Dakota County Planning Department
Hennepin Conservation District
Izaak Walton League
Legislative Commission on Minnesota Resources
McKnight Foundation
Metropolitan Council
Minneapolis Water Works
Minnesota Board of Water and Soil Resources
Minnesota Department of Agriculture
Minnesota Department of Health
Minnesota Department of Natural Resources
Minnesota Extension Service
Minnesota Geological Survey
Minnesota Pollution Control Agency
Minnesota State Planning Agency
Minnesota-Wisconsin Boundary Area Commission
Mississippi River Headwaters Board
National Park Service
National Weather Service
Northern States Power Company
Rivers Council of Minnesota
St. Cloud State University
St. Paul Water Utility
Science Museum of Minnesota
Sierra Club
Stearns County Soil and Water Conservation District
University of Minnesota
University of Minnesota Water Resources Center
University of Wisconsin at LaCrosse
Upper Mississippi River Basin Association
U.S. Army Corps of Engineers
Wisconsin Bureau of Watershed Management

Table 3-16: Initiatives and Studies

Organization		Description / Findings
USGS	National Water Quality Assessment Program 1994-present[60]	▪ Upper Mississippi River Study Unit. ▪ Studies throughout the Upper Mississippi River Basin. ▪ Surface water and groundwater sampling conducted in the Upper Mississippi River. ▪ Land-use studies conducted to assess effects of agricultural land uses on the quality of shallow groundwater. ▪ Samples obtained from domestic wells in the following three land uses: vineyards, almond orchards, and corn-alfalfa-vegetables rotations during 1993-1995. ▪ Results indicate that water impairments were significantly higher in agricultural land-use settings compared to forested and urban settings. Thirty different pesticides were detected in both surface and groundwater samples. Atrazine, its degradation product deethylatrazine, and metachlor were present with 100 percent frequency in surface water samples and 80, 75, and 40 percent frequency in groundwater, respectively, reflecting the relatively high rate of pesticide application associated with the land use.[61] ▪ Other investigations taken up include aquatic biological, water chemistry, and stream flow studies.
Upper Mississippi River Basin Association	Ecosystem Restoration:[62] Environmental Management Program, Navigation and Ecosystem Study Program	▪ The Environmental Management Program of the Upper Mississippi River is an interagency partnership which is implemented by the Army Corp of Engineers and involves coordination with six states. The monitoring focuses on fish, vegetation, and water quality. ▪ The Navigation and Ecosystem Study Program of the Upper Mississippi River is a program designed to make improvements in navigation and ecosystem restoration along the river. Funding for project construction has not been received yet, but it will incorporate new projects that are not feasible under the Environmental Management Program.
Upper Mississippi River Basin Association	Hazardous Spills:[63] Upper Mississippi River Hazardous Spills Coordination Group, Spill Response Planning and Mapping, and the Upper Mississippi River Early Warning Monitoring Network	▪ The Upper Mississippi River Hazardous Spills Coordination Group includes state and federal agencies tasked with contingency planning and response to spills along the river. The group has developed the Upper Mississippi River Spill Response Plan and Resource Manual, which has been adopted by the member agencies. ▪ Efforts have also included a planning and mapping process in response to the Oil Pollution Act of 1990 and creating a rapid response early warning monitoring network for spills along the river.
Upper Mississippi River Basin Association	Water Quality:[64] Upper Mississippi River Water Quality Task Force and Executive Committee	▪ The Task Force and Executive Committee address issues relating to the Clean Water Act and the responsibilities of the involved parties along the river. ▪ Recent publications include: 2007 Water Quality Program Report: Protecting Water Quality Through Interstate Cooperation ▪ Recent survey indicates that between 2002 and 2003, two-thirds of those in attendance went on to implement best management practices to address pollution sources identified in their water quality plans

Table 3-16: Initiatives and Studies

Organization	Description / Findings
Minnesota Pollution Control Agency	▪ State of the Minnesota River: Surface Water Quality Monitoring. Full reports available for 2000 to 2005. ▪ Computer Model a Useful Tool in Water Quality Research, April 2003 ▪ Dissolved Oxygen Problem in the Lower Minnesota River, May 2003 ▪ Minnesota River Basin Plan Fact Sheet, April 2002 ▪ Minnesota River Basin Plan, December 2001 ▪ Minnesota River Study Shows Reductions in Key Pollutants, September 2002 ▪ Minnesota River Watershed Comprehensive Recreational Guidance Document & Trail Corridor Concept Plan. December 1998. ▪ Progress on a Long Voyage: Decades of Effort Show Improvement in Minnesota River Water Quality, January 2007
Minnesota Pollution Control Agency and Minnesota River Board	▪ Publication: Bacteria in the Minnesota River, 1998[65] ▪ Publication: Phosphorus in the Minnesota River[66]
Minnesota Center for Environmental Advocacy	▪ Cleanup of Minnesota River Produces Mixed Results, October 2002
Joint Institute for Energy and Environment	▪ Evaluation of Factors Influencing Fish Assemblages in the Minnesota River
Minnesota River Citizens' Advisory Committee	▪ Minnesota River Citizens' Advisory Committee Progress Report, January 1994 ▪ Working Together: A Plan to Restore the Minnesota River, The Minnesota River Citizens' Advisory Committee's Final Report to the Minnesota Pollution Control Agency, December 1994
Coalition for a Clean Minnesota River	▪ Minnesota River Watershed Drainage Policy Reform Report
Minnesota State University, Mankato Water Resources Center	▪ Perception of Wetland Values in South Central Minnesota, Minnesota State University, Mankato Water Resources Center, May 2005
Legislative Commission on Minnesota Resources	▪ Minnesota River Assessment Project Report, Executive Summary, Report to the Legislative Commission on Minnesota Resources, January 1994
St. Cloud State	▪ Resident Perceptions of the Minnesota River Basin. St. Cloud State Survey. November 2005.
Wisconsin Department of Natural Resources	▪ 2006 Water Quality Assessment: The assessments are reports to Congress in compliance with Section 305(b) of the Clean Water Act and primarily focus on fish and aquatic life use for public health concerns such as consumption.

Elkhorn River Watershed

Elkhorn River Watershed Summary	
Area	• More than 4 million acres
Location	• Eastern Nebraska
Population	• Almost 900,000
Land Use	• Farmland > 90%
Agriculture	• Corn and soybeans account for 80% of total acres harvested • Cattle and calf and hog and pig production makes up 87% of total livestock production

Food Manufacturing	• 29 federally regulated food processing facilities identified
	  • Almost half are manufacturers of prepared feeds and feed ingredients for animals and fowls, except dogs and cats
	  • Top manufacturers are Tyson Foods and Cargill
	  • 135 food manufacturing establishments according to the U.S. Census (2002)

Municipalities	• Population increase of about 6% from 2000 to 2007 • 46 permitted wastewater treatment facilities (2 with 'major' NPDES permits)
Impairments and Concerns	• The majority of the watershed has not been assessed under Clean Water Act § 305(b) • Key pollutants detected include an overabundance of fecal coliform and selenium • 16 waterbodies listed on Nebraska's Threatened and Impaired Waters List (303(d)) • 21 out of 151 waterbodies "impaired" (305(b)) • Top 76% of impairments attributed to selenium, dieldrin, *E. coli*, mercury, nutrient/eutrophication, and polychlorinated biphenyls
Studies and Initiatives	• U.S. Geological Survey National Water Quality Assessment Program

Introduction

The Central Nebraska Basin and Range, which covers most of Nebraska, includes the Elkhorn River watershed and encompasses five 4-digit hydrologic unit codes (HUCs): 1018, 1019, 1020, 1021, and 1022.

The Elkhorn River watershed drains more than 4 million acres and covers almost a quarter of the Central Nebraska Basin and Range, which drain 19 million acres of Nebraska (Table 4-1). It includes all of Cuming, Stanton, and Wayne counties, and parts of Antelope, Boone, Brown, Burt, Cedar, Colfax, Dakota, Dixon, Dodge, Douglas, Garfield, Holt, Knox, Madison, Pierce, Platte, Rock, Sarpy, Thurston, Washington, and Wheeler counties.

Table 4-1: Area and HUCs of the Elkhorn River Watershed

HUC	Watershed Name	Area (acres)
1022	**Elkhorn River Watershed**	**4,449,920**
10220001	Upper Elkhorn	1,843,200
10220002	North Fork Elkhorn	539,520
10220003	Lower Elkhorn	1,395,200
10220004	Logan	672,000

Note on Watersheds, Subwatersheds, Basins and Subbasins

Through the Nebraska Watershed Boundary Dataset Delineation Project, the state of Nebraska has been working on delineating its watersheds to correspond with the system used by the U.S. Geological Survey (USGS). The Nebraska Department of Environmental Quality utilizes a classification system in which the state is divided into thirteen primary river basins. Nebraska Department of Natural Resources led an interagency effort several years ago to develop a statewide watershed database that further sub-divided watersheds beyond the national 8-digit hydrologic unit code (HUC). Further sub-divisions of watersheds have been widely adopted in Nebraska. There are numerous situations in which existing HUC sub-divisions fall outside the USGS national standards (Nebraska Watershed Boundary Dataset 2003).[67] In compiling data for this report, various county, state, and federal data sources are utilized, and differences in geographic scope of the data are noted.

Agriculture

As a percent of the total county area, more than 90 percent of the Elkhorn River watershed is devoted to farm land (Table 4-2). Corn and soybeans for grain make up almost 80 percent of the harvested crops. Cattle and calf and hog and pig production make up 87 percent of total livestock production in the watershed (Table 4-3).[68]

Table 4-2: Elkhorn River Region Land Use (2002)

Total Area of Elkhorn River Watershed (acres)	4,449,920
Total Area of Central Nebraska Basin and Range (acres)	19,199,670
Total County Area[a] (acres)	10,230,925
Land in Farms (acres)	9,423,002
Land in Farms as Percent of Total County Area	92%
Cropland (acres)	5,988,478
Cropland as Percent of Land in Farms	64%
Irrigated Land (acres)	1,686,063
Irrigated Land as Percent of Total County Area	16%

[a] Includes total area of counties within HUCs 102200 (The Elkhorn River Watershed).
Source: 2002 Census of Agriculture (U.S. Department of Agriculture). Nebraska County Level Data.

Table 4-3: Harvested Crops and Livestock Inventory for Counties* of the Elkhorn River Watershed (2002)

Crops Harvested (acres)	
Corn for Grain	2,234,659
Soybeans for Beans	1,775,616
Forage	914,341
Corn for Silage	129,453
Oats for Grain	26,526
Dry Edible Beans	6,676
Winter wheat for Grain	6,357
Wheat for Grain	6,357
Sorghum for Silage	2,987
Sorghum for Grain	2,138
Vegetables	1,686
Barley for Grain	703
Land in Orchards	137
Livestock Inventory (number of animals)	
Cattle and Calves	1,863,783
Hogs and Pigs	1,505,003
Beef Cows	431,030
Milk Cows	32,183
Sheep and Lamb	29,914
Layers	17,021

Source: 2002 Census of Agriculture (U.S. Department of Agriculture).
* The Elkhorn River Watershed consists of all of three and portions of 21 counties. Because the watershed and sub-watershed boundaries differ from county boundaries, the data presented here actually represents an area larger than the actual watershed.

Maple Creek flows within the Lower Elkhorn sub-watershed of the Elkhorn watershed. It drains an area of 236,000 acres covering parts of five eastern Nebraska counties: Colfax, Dodge, Cuming, Platte, and Stanton. It has been selected as one of seven U.S. Geological Survey (USGS) study areas with focus on the transport of agricultural chemicals in intensely farmed regions.[69] About 98 percent of the Maple Creek watershed is devoted to cropland or pasture, and of that, 71 percent is devoted to growing corn and soybeans.

Food Manufacturing

EPA's data systems show 29 federally regulated food processing facilities in the Elkhorn River watershed (Figure 4-1). Almost half of the food processing facilities in the Elkhorn River watershed are manufacturers of prepared feeds and feed ingredients for animals and fowls, except dogs and cats (Table 4-4).

However, many smaller food processing facilities either do not discharge pollutants into waters of the United States and thus do not have NPDES permits or they are "minor" dischargers and are not reported to the federal level. Thus, the data do not include the entire population of food processors in the watershed. In fact, the county-level Census of Manufacturers data for 2002 shows more than 135 establishments in the food manufacturing sector in the counties of the Elkhorn River watershed (Table 4-5).[70]

Figure 4-1: Food Manufacturing Facilities in the Elkhorn River Watershed

Source: Data obtained from EPA's Integrated Data for Enforcement Analysis (IDEA) system on August 8, 2008. Query criteria include the following federal permits and identifiers: NPDES permits, Clean Air Act air permits, Resource Conservation and Recovery Act hazardous waste IDs, and Toxic Release Inventory) reporters between 2004 and 2006.

Table 4-4: Federally Regulated Food Product Facilities* in the Elkhorn River Watersheds			
SIC Code: Industry Description	**Facility Name**	**City**	**NPDES Water Permit (Y/N)**
Upper Elkhorn			
2011: Meat Packaging Plants	Iowa Beef Processors Incorporated	Norfolk	Yes
2023: Dry, Condensed, and Evaporated Dairy Products	Leprino Foods Company	Norfolk	Yes
2048: Prepared Feeds and Feed Ingredients for Animals and Fowls	Pribil Feed & Oil Svc	O'Neill	
	Dougherty's Feed & Supply	Ewing	
2077: Animal and Marine Fats and Oils	Darling International Incorporated	Norfolk	
2086: Bottled and Canned Soft Drinks and Carbonated Water	Wis-Pak Of Norfolk Incorporated	Norfolk	No
North Fork Elkhorn			
2015: Poultry Slaughtering and Processing	Henningsen Foods Incorporated	Norfolk	Yes
2024: Ice Cream and Frozen Desserts	Hiland Roberts Ice Cream Norfolk	Norfolk	Yes
2048: Prepared Feeds and Feed Ingredients for Animals and Fowls	Harvest States Co-Op	Norfolk	No
Lower Elkhorn			
2011: Meat Packaging Plants	Iowa Beef Processors Incorporated	Madison	Yes
	Iowa Beef Processors Incorporated	West Point	Yes
	Wimmers Meat Products Incorporated	West Point	No
	Tyson Fresh Meats Inc	Dakota City	Yes
2022: Natural, Processed, and Imitation Cheese	International Media & Cultures	Orchard	No
2048: Prepared Feeds and Feed Ingredients for Animals and Fowls	Hubbard Feeds Incorporated	Fremont	No
	Grovijohn Feed & Seed Incorporated	Howells	No
	Wisner Farmers Elevator L.L.C.	Wisner	No
	Nutrition Specialties	West Point	No
	Erb Feed & Supply Incorporated	Wisner	No
	Peets Feeds Incorporated	Beemer	No
	Ortmeier's Seed & Feed Incorporated	West Point	No
	Pilger Milling Company	Pilger	No
2075:Soybean Oil Mills	Nebraska Soybean Processing	Scribner	No
Logan			
2015: Poultry Slaughtering and Processing	M G Waldbaum Company	Wakefield	Yes
	Husker Pride Crystal Farms	Wakefield	Yes
	M G Waldbaum Company Big Red Farms	Wakefield	Yes
2048: Prepared Feeds and Feed Ingredients for Animals and Fowls	Hillside Dehy Inc	Uehling	No
	Morrison & Quirk Incorporated	Lyons	No
	Belden Feed Mill	Belden	No

* Federal permits and identifiers considered include NPDES permits, Clean Air Act air permits, Resource Conservation and Recovery Act hazardous waste IDs, and Toxic Release Inventory) reporters between 2004 and 2006.

Table 4-5: Number of Food Manufacturing Establishments in the Counties of the Elkhorn River Watershed	
County[a]	**Number of Establishments**
Cuming County, NE	5
Dakota County, NE	8
Dixon County, NE	1
Dodge County, NE	26
Douglas County, NE	67
Madison County, NE	13
Platte County, NE	10
Sarpy County, NE	5

Source: U.S. Census Bureau. 2002 Economic Census of Manufacturing. County Profiles.
[a] Not all counties in the Elkhorn watersheds are included in the Census data. Of the 24 counties in the watershed, 16 counties had no data for food manufacturing (North American Industry Classification System code 311).

Municipalities

In 2007, the 24 counties that contain the Elkhorn River watershed had a population of 896,319, with an increase of about 6% since the year 2000.[71] The Elkhorn watershed encompasses portions of some of the 24 counties in Nebraska. Because the watershed boundaries differ from county boundaries, this population actually covers an area slightly larger than the watershed.

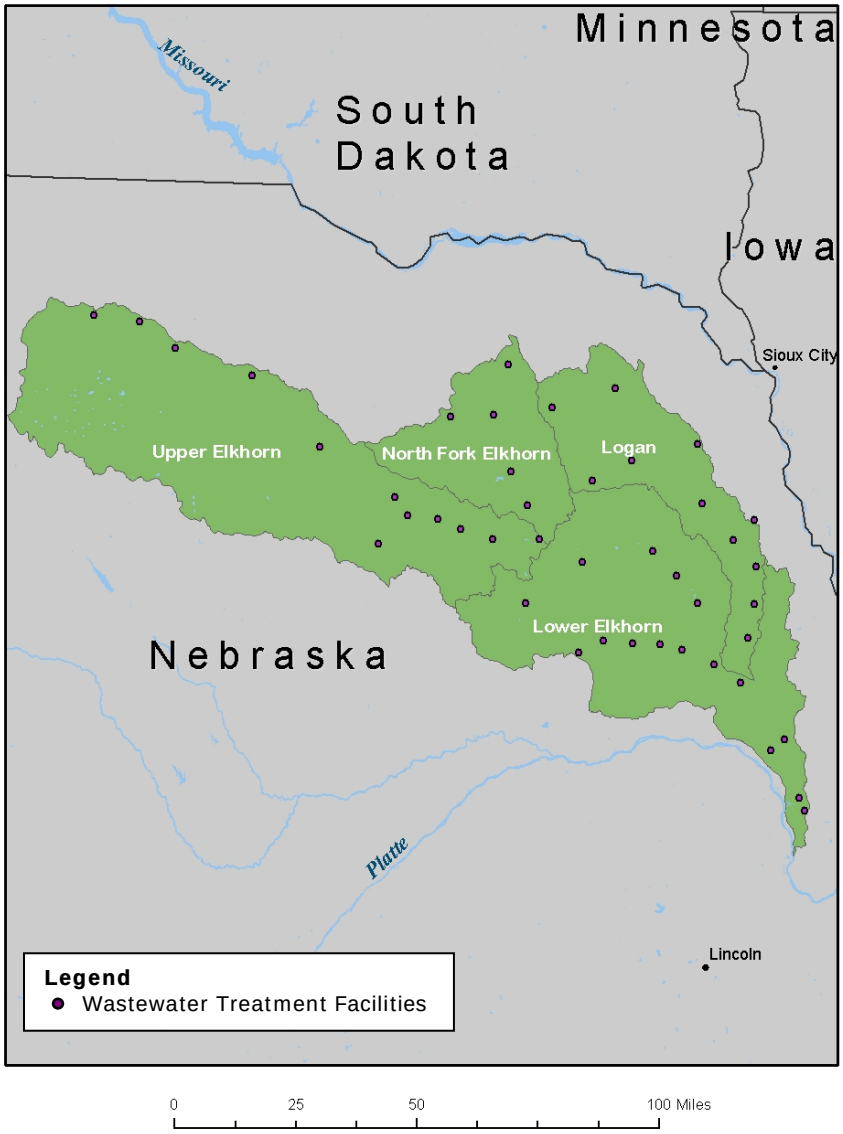
According to EPA's data systems, there are 46 wastewater treatment plants with National Pollutant Discharge Elimination System (NPDES) Permits in the Elkhorn River watershed. Of these 46 facilities, two hold 'major' NPDES designations* (Table 4-6, Figure 4-2).

Table 4-6: Municipal Wastewater Treatment Facilities in the Elkhorn River Watershed		
Sub-Watersheds	**Number of Facilities**	**Number of NPDES Major Water Permits**
Upper Elkhorn	12	1
North Fork Elkhorn	5	0
Lower Elkhorn	17	1
Logan	12	0

Source: Data obtained from EPA's IDEA system on August 8, 2008. Query criteria include the following federal permits and identifiers: NPDES permits, Clean Air Act air permits, Resource Conservation and Recovery Act hazardous waste IDs, and Toxic Release Inventory) reporters between 2004 and 2006.

* Each NPDES permit holder is defined by the program office as a Major or Minor discharger. Classification as a major discharger generally involves factors relating to the significance of the discharger's impact on the environment, such as nature and quantity of pollutants discharged, character and assimilative capacity of the receiving waters, presence of toxic pollutants in the discharge, and discharger's compliance history.

Figure 4-2: Wastewater Treatment Facilities in the Elkhorn River Basin



Source: Data generated from EPA's IDEA system for Wastewater Treatment Facilities, July 2008. Federal permits and identifiers considered include NPDES permits, Clean Air Act air permits, Resource Conservation and Recovery Act hazardous waste IDs, and Toxic Release Inventory) reporters between 2004 and 2006.

Impairments and Concerns[†]

The 2006 Clean Water Act Section 303(d) Threatened and Impaired Waters List for the Elkhorn River watershed, which lists waterbodies that are impaired or are threatened to be impaired by pollutants, includes 16 waters listed

[†] The impairments cited here represent the monitoring activities taking place in the watershed and may not reflect the complete condition of the watershed.

as "impaired." Of the common causes of impairment, fecal coliform and selenium are the most frequent. Selenium levels are often elevated in watersheds when it leaches from irrigated soils (Table 4-7).

Table 4-7: Common Causes of 303(d) Impairment for the Elkhorn River Watershed

Sub-Watersheds	No. of Waterbodies Listed as Impaired	Causes of Impairment	No. of Waterbodies with Causes of Impairment Reported
Upper Elkhorn	6	Fecal Coliform	4
		pH	1
		Mercury	1
		Nutrients	1
North Fork Elkhorn	2	pH	1
		Selenium	1
Lower Elkhorn	6	Selenium	3
		Fecal Coliform	2
		PCBs	1
		Mercury	1
		pH	1
		Nutrients	1
		Dieldrin	1
Logan	2	Selenium	2
		Dieldrin	1
		PCBs	1

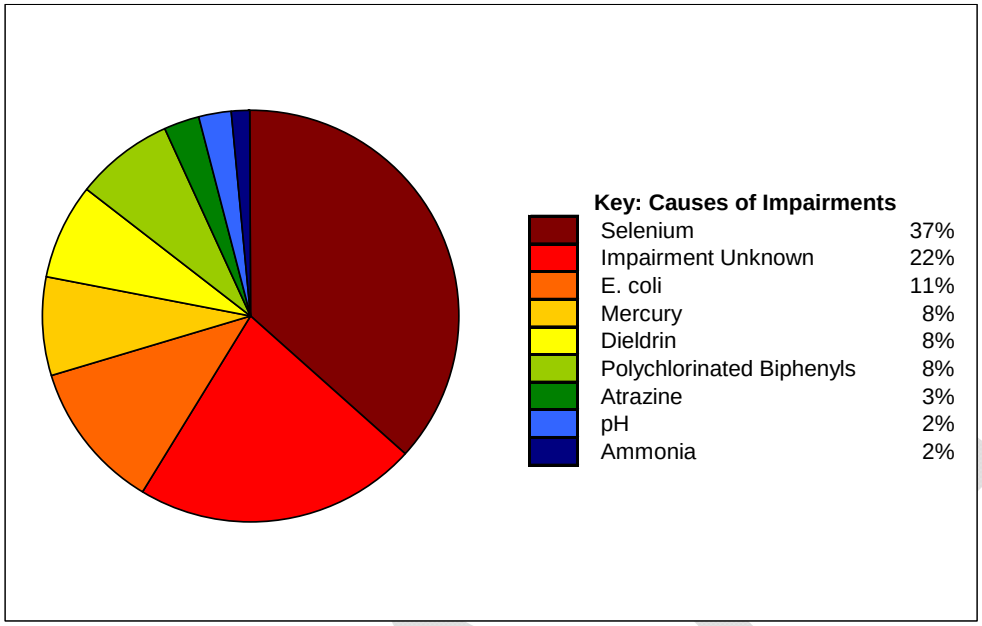
The Nebraska 2006 Clean Water Act Section 305(b) National Water Quality Inventory Reports, which discloses conditions of all assessed waterbodies in the state including causes of impairment from types of pollution and likely sources of pollution, have 21 waterbodies in the Elkhorn River watershed listed as "impaired" (Table 4-8); yet, the majority of the Elkhorn River watershed has not been assessed. However, since the 1970s, the state of Nebraska has conducted more than a million surface water quality monitoring analyses. Thousands of samples are taken yearly for a number of parameters, which serve a variety of purposes. Some of the monitoring categories are nutrients, biological, metals, common constituents, pesticides, and physical characteristics.[72]

Table 4-8: Elkhorn River Watershed 305(b) List of Impaired Waters Summary (2006)

HUC	Watershed Name	Good	Impaired	Not Assessed	Total
10220001	Upper Elkhorn	5	6	33	44
10220002	North Fork Elkhorn	2	2	10	14
10220003	Lower Elkhorn	4	9	53	66
10220004	Logan	2	4	21	27
102200	**Elkhorn River**	13	21	117	151

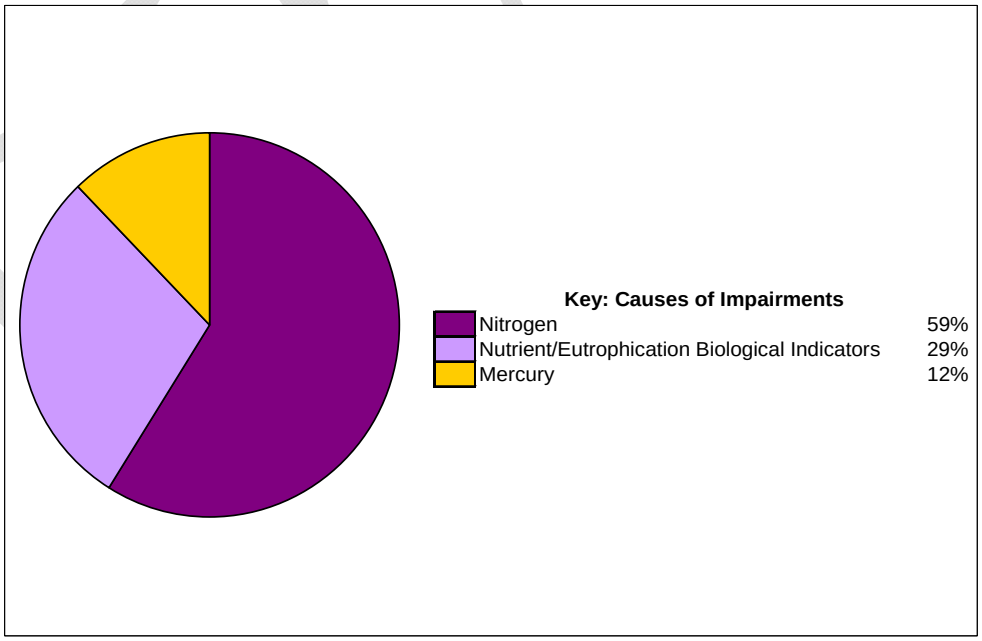
Selenium, dieldrin, E. coli, mercury, nutrient/eutrophication, and polychlorinated biphenyls made up more than three quarters of the 305(b) waterbodies impairments reported in the Elkhorn River Watershed. The most common causes of impairments in the watershed are presented as a percent of the total miles of streams and rivers and acres of waterbodies assessed over the Elkhorn River watershed (Figures 4-3 and 4-4).[73]

Figure 4-3: 305(b) Causes of Impairment of the Rivers, Streams and Creeks of the Elkhorn River Watershed (as percent of total miles assessed)



Source: EPA Office of Water website, [http://iaspub.epa.gov/waters10/attains_nation_cy.control?p_report_type=T]

Figure 4-4: 305(b) Causes of Impairment of the Lakes, Ponds, and Reservoirs of the Elkhorn River Watershed (as percent of total acres assessed)

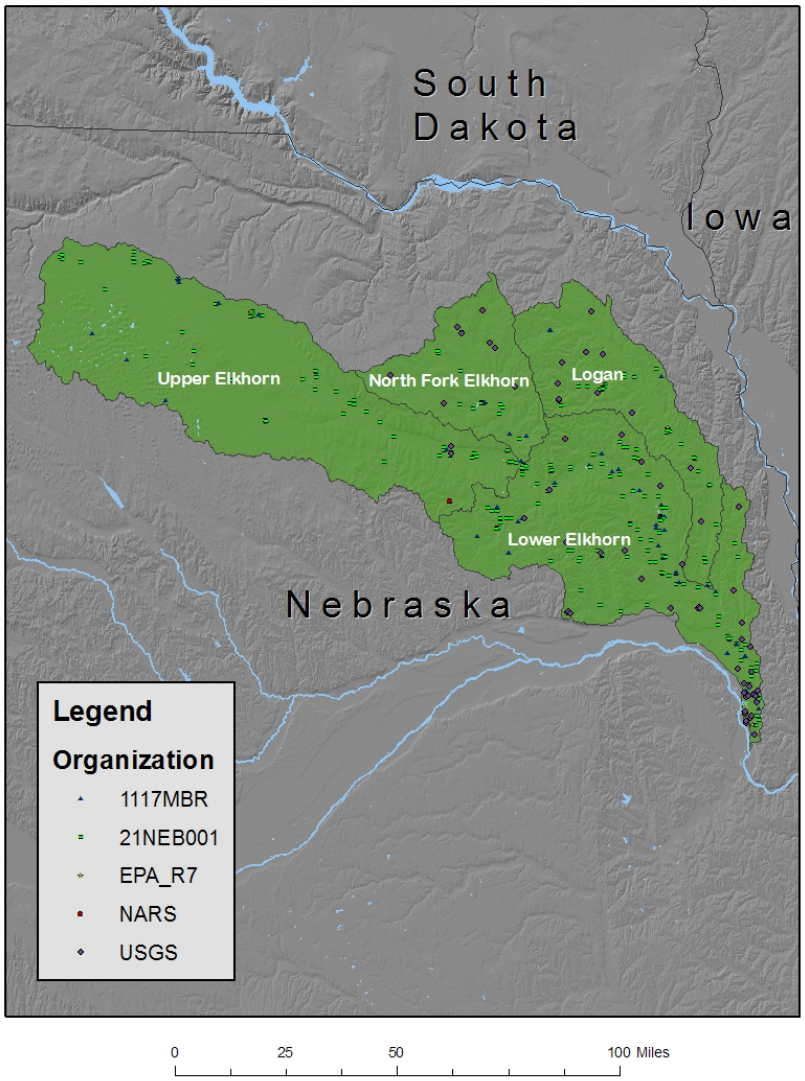


Source: EPA Office of Water website, [http://iaspub.epa.gov/waters10/attains_nation_cy.control?p_report_type=T]

Water Quality Monitoring Stations

There are a number of organizations that routinely monitor water quality in the 24 counties of the Elkhorn River watershed. While various organizations focus their monitoring efforts on particular pollutants, most report to EPA's Storage and Retrieval Data Warehouse (STORET). STORET is a data management system containing water quality information for the nation's waters. The organizations that report water quality data STORET are from various state agencies in Nebraska, EPA Region 7, and the National Aquatic Resource Survey (NARS). The USGS National Water Information System stores water quality data of more than 1.5 million sites throughout the country, and conducts monitoring for the entire spectrum of impairments as well as quantity, distribution, and movement of water parameters. USGS has 180 stations operating in the Elkhorn River watershed. (Figure 4-5, Table 4-9).

Figure 4-5: Water Quality Monitoring Stations in the Elkhorn River Watershed



Source: EPA's STORET, USGS National Water Information System.

Table 4-9: Number of Water Quality Monitoring Stations in the Elkhorn River Watersheds*	
Water Monitoring Organizations	**Elkhorn River Watershed**
Nebraska Department of Environmental Quality	300
EPA Region 7	82
EPA Region 7	14
National Aquatic Resource Survey (NARS)	12
USGS	180
Total	588

***Monitoring stations active between 2002 to present, with at least one type of water quality parameter tested at the site. Monitoring station data collected from the USGS National Water Information System and EPA's STORET.

Studies and Initiatives

The National Water Quality Assessment Program has gone through two cycles of studies on important watersheds, called study units, in the United States. The first cycle aimed to describe current water quality conditions and how those conditions are changing over time and to improve understanding of how both human and natural factors affect water quality. The goals of the study units in Cycle II of the National Water Quality Assessment Program are to assess the status and trends of water quality to understand the factors affecting it and to build on the results from Cycle I. Cycle II assessments are conducted in the second decade of the program, which started in 2001. Because central Nebraska is considered an intensely agricultural study unit, it is of particular interest, and its assessment is being continued in Cycle II of the National Water Quality Assessment Program.

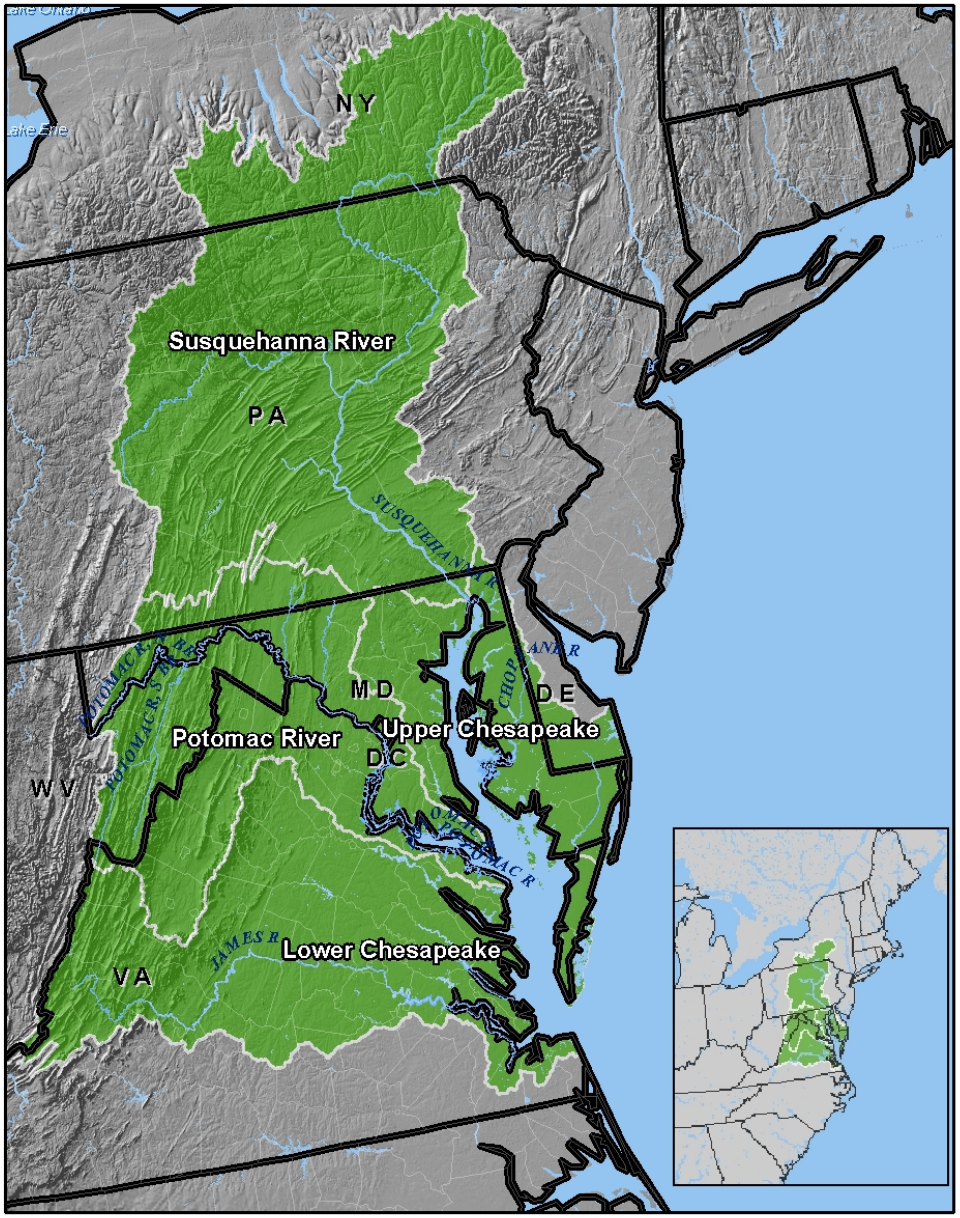
Major water quality issues in the region primarily originate from the concentrated agricultural practices in the region. There are five activities on which Cycle II is focusing, one of which concerns the agricultural chemicals in the drainage of Maple Creek, which is within the Lower Elkhorn sub-watershed of the Elkhorn River. Results from Cycle I showed that the Elkhorn River watershed is responsible for the majority of herbicides transported out of the larger basin. It is a watershed influenced by heavy use of agricultural chemicals, distinct geological features, various types of agricultural management practices, and other water quality issues.[74]

Table 4-10 summarizes some of the major local, regional, state, and federal programs and coalitions striving to conserve and improve the water resources of the region.

Table 4-10: Initiatives and Studies

Organization	Description / Findings
USGS, National Water Quality Assessment Program (1994-present)	▪ Environmental Setting of Maple Creek Watershed, Nebraska. ▪ Water-Quality Assessment of the Central Nebraska Basins—Entering a New Decade.
USGS	▪ Domagalski, Joseph L., Ator, Scott, Coupe, Richard, McCarthy, Kathleen, Lampe, David, Sandstrom, Mark, and Baker, Nancy. Comparative study of transport processes of nitrogen, phosphorus, and herbicides to streams in five agricultural basins, USA. J. Environ. Qual. 37: 1158-1169 (2008). ▪ Capel, Paul D., McCarthy, Kathleen, and Barbash, Jack E. National, holistic, watershed-scale approach to understand the sources, transport, and fate of agricultural chemicals. J. Environ. Qual. 37: 983-993 (2008).

Chesapeake Bay Watershed



Chesapeake Bay Watershed Summary	
Area	• 41 million acres
Location	• 6 States: VA, PA, MD, NY, WV, DE, and District of Columbia
Population	• Almost 17 million, with MD and VA accounting for 60% of population • Projected population of more than 20 million by 2030
Land Use	• Undeveloped ~ 60% • Agriculture ~ 30 % • Urban / Suburban Lands ~ 9%
Agriculture	• ~ 60% of farmland is dedicated to harvesting crops • Forage, corn, soybeans, wheat, and barley account for 95% of total acres harvested • Intensive poultry production in MD, VA, and DE, concentrating on eastern part of watershed • Other livestock production includes cattle and calves (majority in VA), and layer chickens, dairy and hogs (majority in PA)
Food Manufacturing	• Nearly 600 federally regulated food processing facilities • Most common industries include animal feed, poultry slaughtering and processing, and canned fruits and vegetables • Large federally regulated corporations include Pilgrims Pride, Tyson Food, Perdue Farms, Good Humor, Knouse Foods, Hershey's, Coca Cola, Cargill, and McCormick
Municipalities	• High rate of urbanization and land conversion to impervious surfaces • Watershed has more than 1,200 federally regulated wastewater treatment facilities with 20% holding "major" designations under the National Pollutant Discharge Elimination System
Impairments and Concerns	• Key pollutants detected include an overabundance of nutrients, sediment, mercury, pesticides (including herbicides), and pathogenic contaminants • Nitrogen: ~318 million lbs. reached the Bay in 2007, with agriculture contributing the largest share (40%) • Phosphorus: ~ 15 million lbs. reached the Bay in 2007, with agriculture contributing the largest share (46%) • Almost 3,000 waterbodies listed on Bay state's Threatened and Impaired Waters lists (303(d)) • 3,946 waterbodies listed as "impaired" in the Bay states' Water Quality Inventory Reports (305(b)) • Top 90% of impairments attributed to sediment, pathogens, pH, nutrients, metals, and pesticides
Studies and Initiatives	• Chesapeake Bay Program: Chesapeake 2000 Agreement, goals for 2010 • U.S. Geological Survey: National Water Quality Assessment Program Agriculture Chemicals Study • U.S. Department of Agriculture Conservation Effects Assessment Program

Introduction

The Chesapeake Bay is the nation's largest estuary covering an area of more than 41 million acres. It is fed by 48 major rivers and more than 100 smaller tributaries. About half of the water volume in the Bay comes from the freshwater rivers that drain into it.[75] The other half of the water volume comes from the salt waters of the Atlantic Ocean, resulting in a gradual increase in salinity from the north to the Bay's mouth in the south. The Bay's variety of salinity levels allows it to support more than 3,700 species of fresh and marine life forms, making it one of the most productive and valuable ecosystems in the country.[76]

The Chesapeake Bay watershed encompasses portions of six states - Virginia, Pennsylvania, Maryland, New York, West Virginia, and Delaware - and the District of Columbia (Table 5-1). Virginia and Pennsylvania together make up 72 percent of the Chesapeake Bay watershed, though only about half of each state's area is within the watershed. With the exception of Garrett and Worcester counties, which partially fall within the watershed, the state of Maryland is entirely located within the Chesapeake Bay watershed boundary.

The Chesapeake Bay watershed is home to almost 17 million people in a number of major cities. The watershed also contains a large industrial and agricultural industry. As a result, the major rivers of the watershed, and the Chesapeake Bay itself, are facing significant environmental pressures. The overall health of the Chesapeake Bay is impaired by excess nutrients and sediment, toxic chemical contaminants, and air pollution. One of the key contributors to the Chesapeake Bay's restoration efforts is the Chesapeake Bay Program, an extensive regional partnership consisting of Maryland, Pennsylvania, Virginia, the District of Columbia, the Chesapeake Bay Commission, various citizen advisory groups, and the Environmental Protection Agency, representing the federal government. The Chesapeake Bay Program leads and directs the research and restoration efforts in the area. The Program and its partners facilitate interstate cooperation and address local challenges of the area through comprehensive goal-setting agreements such as the Chesapeake 2000 Agreement and regionalized targeted efforts such as Tributary Strategies implemented by each of the Chesapeake Bay states.[77]

Note on Watershed Delineations

The Chesapeake Bay Watershed encompasses portions of six states - Virginia, Pennsylvania, Maryland, New York, West Virginia, and Delaware - and the District of Columbia. While the states utilize varying systems to delineate the sub-watersheds within the watershed, in order to standardize the data and information presented, this report is organized around the 4-digit hydrologic unit codes (HUCs) utilized by the U.S. Geological Survey (USGS). The Chesapeake Bay watershed is comprised of four 4-digit HUCs (Table 5-2). Another delineation utilized is that of the Chesapeake Bay Program's Tributary Strategies which works with the Chesapeake Bay states to subdivide the watershed into nine major river basins, then further into 36 comprehensive political boundaries (see Appendix A, Figure A-1). The nine major river basins approximately correspond to the four 4-digit HUCs delineated by the USGS. In compiling data for this report, county, state, and federal data are utilized and differences in geographic scope of the data are noted.

Table 5-1: Area of States Within the Chesapeake Bay Watershed			
State	**Acres in Watershed**	**% of State**	**% of Watershed**
Virginia (VA)	15,307,820	56%	37
Pennsylvania (PA)	14,477,457	49%	35
Maryland (MD)	7,407,058	93%	18
New York (NY)	4,007,921	11%	10
West Virginia (WV)	2,294,349	15%	6
Delaware (DE)	458,356	29%	1
District of Columbia (DC)	43,738	100%	0.11

Source: U.S. Department of Agriculture. Natural Resource Conservation Service. Resource Inventory and Assessment Division. May 2006. Obtained from Chesapeake Bay Program.

Table 5-2: Delineations of the Chesapeake Bay Watershed					
Tributary Strategy Basin Names[a]	**4-Digit HUC**	**HUC Name**	**Area (acres)**	**States**	**Estimated % of HUC**
Susquehanna	0205	Susquehanna River	17,403,520	NY	22
				PA	78
Eastern Shore- MD	0206	Upper Chesapeake	5,746,560	DE	8
Western Shore					
Patuxent				MD	92
Potomac	0207	Potomac River	9,351,040	PA	16
				WV	22
				VA	35
				DC	0.5
				MD	27
Rappahannock	0208	Lower Chesapeake	18,366,720	VA	100
York					
James					
Eastern Shore - VA					

Source: USGS. HUC area data available at http://water.usgs.gov/GIS/huc_name.html
Note: Eight-digit HUCs are presented in Appendix A, Table A-1
[a] The Tributary Strategy Basin boundaries approximate the HUC codes shown here, but do not map exactly.

Agriculture

Due to the high land to water ratio of the Chesapeake Bay and its watershed of 14 to 1, the largest of any estuary in the world, land use within the watershed has a significant impact on the bay's health.[78] About 58 percent of the watershed is undeveloped and largely forested. Nine percent is dedicated to urban and suburban uses and roughly a third of the watershed is agricultural land, with over 87,000 working farms throughout the watershed.[79, 80] According to the 2002 Census of Agriculture, about 60 percent of the farmland is dedicated to harvesting crops (Table 5-3).[81]

Table 5-3: Land Use in the Counties of the Chesapeake Bay Watershed (2002)

State	Total County Area (acres)	Land in Farms (acres)	Land in Farms as % of Total County Area	Total Cropland (acres)	Cropland as % of Land in Farms	Irrigated Land (acres)	Irrigated Land as % of Total County Area
VA	14,482,605	4,828,790	33%	2,538,230	53%	61,149	0.42%
PA	16,496,269	4,829,965	29%	3,287,680	68%	29,547	0.18%
MD	7,940,480	2,077,630	26%	1,487,218	72%	80,828	1.02%
NY	6,893,818	2,066,266	30%	1,176,926	57%	6,258	0.09%
WV	2,232,045	797,541	36%	279,516	35%	779	0.03%
DE	977,472	468,832	48%	397,255	85%	94,530	9.67%

Source: 2002 Census of Agriculture (U.S. Department of Agriculture).
Note: Because the watershed boundaries differ from county boundaries, the data presented here actually represents a slightly larger area than the actual watershed. The counties included in the calculation are either entirely or partially contained within the Chesapeake Bay watershed. Counties with less than 50,000 acres inside the watershed were excluded from the calculation. For the list of counties included in the analysis by state, see Appendix A, Table A-2.

The agricultural activities in the watershed include dairy, beef, poultry, and hog operations, as well as grain and produce production, and tree and shrub nurseries. The most common use of cropland in the Chesapeake Bay watershed is for forage, corn, soybeans, wheat, and barley harvesting, together making up almost 95 percent of total acres harvested (Table 5-4).[82] The watershed also has an extensive broiler chicken production industry. Maryland, Virginia, and Delaware are in the top ten broiler producing states in the country and make up more than 80 percent of the production in the Chesapeake Bay watershed. Broiler operations are primarily concentrated in the eastern part of the watershed. Virginia also has an extensive cattle and calf industry with about one-third of the total watershed production. Other livestock production is mostly concentrated in Pennsylvania, accounting for more than 85 percent of layer chicken production and almost 60 percent of dairy cow production in the watershed. Pennsylvania also accounts for more than 90 percent the watershed's hog and pig production (Table 5-4).[83]

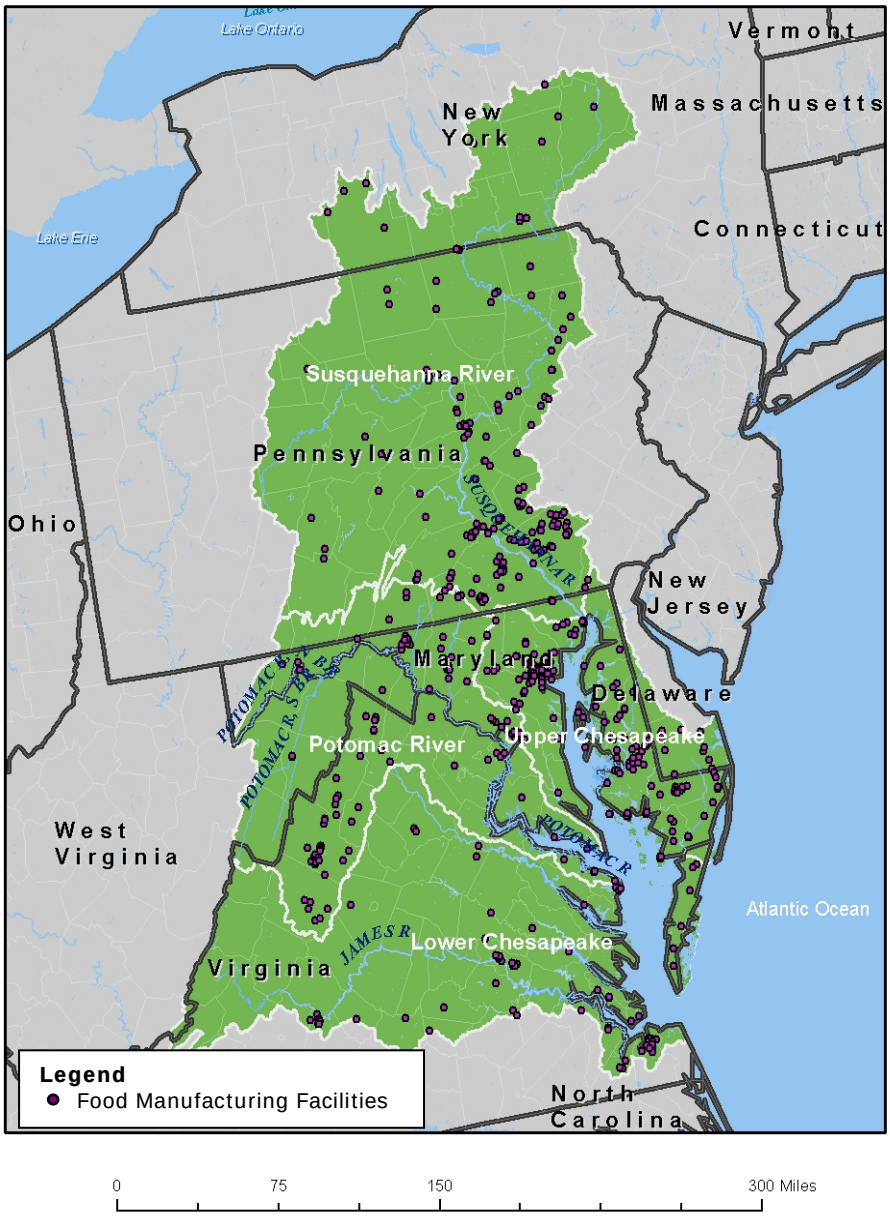
Table 5-4: Harvested Crops and Livestock Inventory for Counties[a] of the Chesapeake Bay Watershed (2002)							
	VA	**PA**	**MD**	**NY**	**WV**	**DE**	**Total**
Crops Harvested (acres)							
All Cotton	38,895	-	-	-	-	-	**38,895**
Barley for Grain	35,825	43,289	36,158	3,758	1,206	21,347	**141,583**
Corn for Grain	282,706	517,204	406,841	68,572	18,490	143,965	**1,437,778**
Corn for Silage	93,207	418,701	72,962	118,298	9,540	9,025	**721,733**
Dry Edible Beans	-	360	-	1,182	-	-	**1,542**
Forage	813,531	1,205,927	227,727	652,468	121,419	13,384	**3,034,456**
Land in Orchards	22,715	33,186	4,886	3,749	8,282	-	**72,818**
Oats for Grain	2,292	61,982	3,482	24,035	366	173	**92,330**
Peanuts for Nuts	27,364	-	-		-	-	**27,364**
Potatoes	2,592	7,095	1,781	5,407	23	2,815	**19,713**
Sorghum for Grain	1,117	853	2,859	75	-	455	**5,359**
Sorghum for Silage	1,294	4,811	768	1,080	447	-	**8,400**
Soybeans for Beans	362,490	265,794	465,612	5,085	10,475	154,876	**1,264,332**
Sunflower Seeds	54	18	81	5	-	-	**158**
Sweet Potatoes	313	23	151	-	-	-	**487**
Tobacco	1,407	5,388	1,122	-	-	-	**7,917**
Vegetables	19,563	32,615	31,246	5,933	582	38,297	**128,236**
Wheat for Grain	139,145	126,210	162,011	6,271	5,113	41,468	**480,218**
Livestock Inventory (number of animals)							
Beef Cows	336,608	111,021	52,624	27,314	33,041	3,043	**563,651**
Broiler Chickens	259,799,477	117,954,784	286,500,467	22,982	88,685,621	223,678,004	**976,641,335**
Cattle and Calves	896,731	1,174,824	240,918	384,652	108,325	19,362	**2,824,812**
Hogs and Pigs	32,841	1,064,901	27,777	18,292	961	11,689	**1,156,461**
Layers 20 weeks and older	1,558,201	19,381,384	409,824	19,841	1,352,027	80,007	**22,801,284**
Milk Cows	72,577	448,961	72,343	168,511	4,318	7,935	**774,645**
Sheep and Lamb	46,456	58,004	22,611	26,920	12,561	662	**167,214**

Source: 2002 Census of Agriculture (U.S. Department of Agriculture).
Note: - represents either that data was withheld to avoid disclosing data for individual farms, or activity is not reported.
[a] Because the watershed boundaries differ from county boundaries, the data presented here actually represents a slightly larger area than the actual watershed. The counties included in the calculation are either entirely or partially contained within the Chesapeake Bay watershed. Counties with less than 50,000 acres inside the watershed were excluded from the calculation. For the list of counties included in the analysis by state see Appendix A, Table A-2.

Food Manufacturing

EPA data systems show nearly 600 federally regulated food processing facilities in the Chesapeake Bay watershed (Figure 5-1, Table 5-5). The most common food manufacturing industries include animal feed, poultry slaughtering and processing, and canned fruits and vegetables.

Figure 5-1: Food Manufacturing Facilities in the Chesapeake Bay Watershed



Source: Data obtained from EPA's Integrated Data for Enforcement Analysis (IDEA) system on July 8, 2008. Query criteria include the following federal permits and identifiers: NPDES water permits, Clean Air Act air permits, Resource Conservation and Recovery Act hazardous waste IDs, and Toxic Release Inventory reporters between 2004 and 2006.

Table 5-5: Number of Food Manufacturing Establishments in the Chesapeake Bay Watershed

SIC Code	Industry Description	Sub-Watersheds				Total
		Susquehanna	Upper Chesapeake	Potomac	Lower Chesapeake	
2048	Prepared Feeds and Feed Ingredients for Animals and Fowls	36	26	20	4	**86**
2015	Poultry Slaughtering and Processing	9	18	16	3	**46**
2033	Canned Fruits, Vegetables, Preserves, Jams,	8	26	10	2	**46**
2099	Miscellaneous Food Preparations	6	22	5	5	**38**
2086	Bottled/Canned Soft Drinks and Carbonated Water	8	10	10	7	**35**
2092	Prepared Fresh or Frozen Fish and Seafoods	-	25	4	4	**33**
2051	Bread and Other Bakery Products	13	7	4	6	**30**
2026	Fluid Milk	6	4	12	3	**25**
2013	Sausages and Other Prepared Meat Products	6	9	1	3	**19**
2011	Meat Packing Plants	4	6	3	5	**18**
2024	Ice Cream and Frozen Desserts	6	5	4	1	**16**
2041	Flour and Other Grain Mill Products	-	1	10	4	**15**
2095	Roasted Coffee	2	4	5	4	**15**
2096	Potato Chips, Corn Chips, and Similar Snacks	11	3	-	1	**15**
2022	Natural, Processed, and Imitation Cheese	9	-	2	-	**11**
2066:	Chocolate and Cocoa Products	9	-	1	-	**10**
2091	Canned and Cured Fish and Seafoods	-	8	1	1	**10**
2047	Dog and Cat Food	4	2	1	2	**9**
2077	Animal and Marine Fats and Oils	3	-	1	5	**9**
2097	Manufactured Ice	4	2	3	-	**9**
2035	Pickled Fruits and Vegetables, Vegetable Sauces	-	7	1	-	**8**
2037	Frozen Fruits, Fruit Juices, and Vegetables	3	5	-	-	**8**
2052	Cookies and Crackers	4	-	2	2	**8**
2064	Candy and Other Confectionery Products	4	3	-	-	**7**
2085	Distilled and Blended Liquors	-	5	-	1	**6**
2087	Flavoring Extracts and Flavoring Syrups	-	4	1	1	**6**
2023	Dry, Condensed, and Evaporated Dairy Products	4	1	-	-	**5**
2038	Frozen Specialties	2	1	1	1	**5**
2098	Macaroni, Spaghetti, Vermicelli, and Noodles	3	-	2	-	**5**
2043	Cereal Breakfast Foods	4	-	-	-	**4**
2068	Salted and Roasted Nuts and Seeds	1	1	-	2	**4**
2075	Soybean Oil Mills	1	-	1	2	**4**
2082	Malt Beverages	1	1	1	1	**4**
2032	Canned Specialties	3	-	-	-	**3**
2084	Wines, Brandy, and Brandy Spirits	-	2	-	1	**3**
2046	Wet Corn Milling		2	-	-	**2**
2079	Shortening, Table Oils, Margarine, and Other Edible Fats and Oils	-	2	-	-	**2**
2021	Creamery Butter	1	-	-	-	**1**
2034	Dried/Dehydrated Fruits, Vegetables, Soup Mixes	1	-	-	-	**1**
2062	Cane Sugar Refining	-	1	-	-	**1**
2076	Vegetable Oil Mills, Except Corn, Cottonseed, and Soybean	-	-	1	-	**1**

Source: Data obtained from EPA's IDEA system on July 8, 2008. Query criteria include the following federal permits and identifiers: NPDES permits, Clean Air Act air permits, Resource Conservation and Recovery Act hazardous waste IDs, and Toxic Release Inventory reporters between 2004 and 2006.

However, many smaller food processing facilities either do not discharge pollutants into waters of the United States and thus do not have NPDES permits or they are "minor" dischargers and are not reported to the federal level. Thus, the data do not include the entire population of food processors in the watershed. In fact, the county-level Census of Manufacturers County Business Patterns data for 2006 shows more than 1,000 establishments in the food manufacturing sector in the counties of the Chesapeake Bay watershed (Table 5-6).[84]

Table 5-6: Number of Food Manufacturing Establishments in the Counties of the Chesapeake Bay Watershed by State

PA	MD	VA	NY	DE	WV	Total Watershed
543	300	218	84	39	9	**1,193**

Source: U.S. Census Bureau. Economic Census of Manufacturing. 2006 County Business Patterns. North American Industry Classification System code 311.
Note: Because the watershed boundaries differ from county boundaries, the data presented here actually represents a slightly larger area than the actual watershed. The counties included in the calculation are either entirely or partially contained within the Chesapeake Bay watershed. Counties with less than 50,000 acres inside the watershed were excluded from the calculation. For the list of counties included in the analysis by state, see Appendix A, Table A-2.

The Chesapeake Bay watershed harbors a significant number of large food manufacturing corporations. The region's meat product manufacturing industry is dominated by the top three poultry producers in the United States, Pilgrims Pride, Tyson Foods, and Perdue Farms, with the latter having the greatest number of federally regulated facilities in the watershed. Other major companies in the area include Good Humor, Knouse Foods, Hershey's, Coca Cola, McCormick, Pepsi, and Southern States Cooperative (Table 5-7).

Table 5-7: Top Federally Regulated Companies in the Chesapeake Bay Watershed

Company Name[a]	Number of Federally Regulated Facilities				
	Susquehanna	Upper Chesapeake	Potomac	Lower Chesapeake	Total
SIC 201: Meat Products					
Perdue	-	7	1	1	**9**
Pilgrim's Pride	1	-	5	-	**6**
Tyson Food	1	1	1	2	**5**
Cargill	1	1	1	-	**3**
Mountair Farms	-	3	-	-	**3**
Smithfield Foods	-	-	1	2	**3**
SIC 202: Dairy Products					
Good Humor	-	1	2	1	**4**
Hershey's	2	1	-	-	**3**
Kemps	3	-	-	-	**3**
Morningstar Foods	-	-	3	-	**3**
SIC 203: Canned, Frozen, and Preserved Fruits, Vegetables, and Food Specialties					
Knouse Foods	4	-	5	-	**9**
SIC 204: Grain Mill Products					
Southern States Cooperative	1	4	2	1	**8**
Wenger's Feed Mill	5	1	-	-	**6**
Agway Inc.	5	-	-	-	**5**
Cargill	2	-	2	1	**5**
Perdue	-	5	-	-	**5**
Purina Mills	3	-	1	1	**5**
ConAgra Foods	4	-	-	-	**4**
Tyson Food	-	2	1	1	**4**
Pennfield Corporation	3	-	-	-	**3**
SIC 205: Bakery Products					
Stroehmann Bakeries	4	-	-	-	**4**
General Mills	3	-	-	-	**3**
SIC 206: Sugar and Confectionery Products					
Hershey's	9	-	1	-	**10**
Cargill	3	-	-	-	**3**
SIC 208: Beverages					
Coca Cola	2	4	6	2	**14**
Pepsi	2	3	2	3	**10**
SIC 209: Miscellaneous Food Preparations and Kindred Products					
McCormick	-	7	-	-	**7**
Frito-Lay	3	2	-	1	**6**

Source: Data obtained from EPA's IDEA system on July 8, 2008. Query criteria include the following federal permits and identifiers: NPDES permits, Clean Air Act air permits, Resource Conservation and Recovery Act hazardous waste IDs, and Toxic Release Inventory reporters between 2004 and 2006.

[a] Only those companies with 3 or more facilities are shown.

Municipalities

Over the past twenty years the Chesapeake Bay watershed has experienced one of the largest rises in population among estuarine U.S. watersheds, making it one of the most populous coastal areas in the country.[85] The watershed population was at 16.6 million in 2006 and was projected to exceed 20 million by 2030.[86] Development has been identified to be the leading cause of deforestation over the past two decades. Between 1982 and 1997, more than 750,000 acres of land have been developed, suggesting a conversion rate of almost 100 acres per day.[87] It is estimated that at least 36 percent of all forestland in the watershed is at high risk to development over the next ten years.[88] Impervious surfaces are often assessed to calculate the rate of development within a region. One of the key findings of a recent U.S. Geological Survey (USGS) report stated that between 1990 and 2000, though the watershed's population increased by only eight percent, the amount of impervious area increased by nearly 41 percent, reflecting a disproportionately high rate of development.[89]

Although a large percent of the land area in the Chesapeake Bay watershed is served by residential septic systems, the rate of development and population are increasing, as is the need for a greater number of municipal wastewater treatment facilities.[90] On average, wastewater treatment facilities annually deliver about 3.1 pounds of nitrogen per person to the Chesapeake Bay and its rivers.[91] According to EPA's data systems, there are 1,272 wastewater treatment facilities with National Pollutant Discharge Elimination System (NPDES) permits in the Chesapeake Bay watershed with almost 20 percent holding 'major' NPDES designations [§§§] (Figure 5-2, Table 5-8).

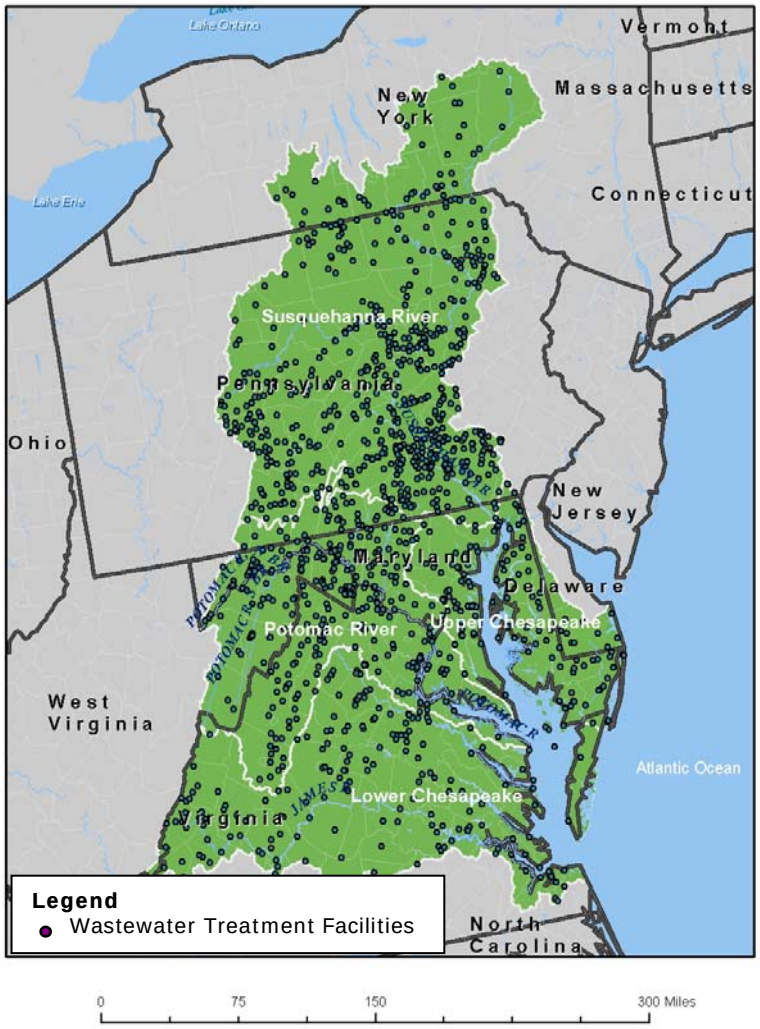
Table 5-8: Municipal Wastewater Treatment Facilities in the Chesapeake Bay Watershed

Sub-Watershed	Number of Facilities	Number of NPDES Major Water Permits
Susquehanna River	619	111
Upper Chesapeake	137	42
Potomac River	336	61
Lower Chesapeake	180	36

Source: Data obtained from EPA's IDEA system on July 8, 2008. Query criteria include the following federal permits and identifiers: NPDES permits, Clean Air Act air permits, Resource Conservation and Recovery Act hazardous waste IDs, and Toxic Release Inventory reporters between 2004 and 2006.

[§§§] Each NPDES permit holder is defined by the program office as a Major or Minor discharger. Classification as a major discharger generally involves factors relating to the significance of the discharger's impact on the environment, such as nature and quantity of pollutants discharged, character and assimilative capacity of the receiving waters, presence of toxic pollutants in the discharge, and discharger's compliance history.

Figure 5-2: Wastewater Treatment Facilities in the Chesapeake Bay Watershed



Source: Data obtained from EPA's IDEA system on July 8, 2008. Query criteria include the following federal permits and identifiers: NPDES permits, Clean Air Act air permits, Resource Conservation and Recovery Act hazardous waste IDs, and Toxic Release Inventory reporters between 2004 and 2006.

Impairments and Concerns[****]

Due in part to the rapidly increasing population of the Chesapeake Bay watershed and in part to the large areas of intensive agriculture and concentrated industry, the Chesapeake Bay is one of the nation's most critically polluted areas. Some of the more prevalent pollutants found in the Chesapeake Bay watershed include an overabundance of nutrients, sediment, mercury, pesticides (including herbicides), and pathogens.

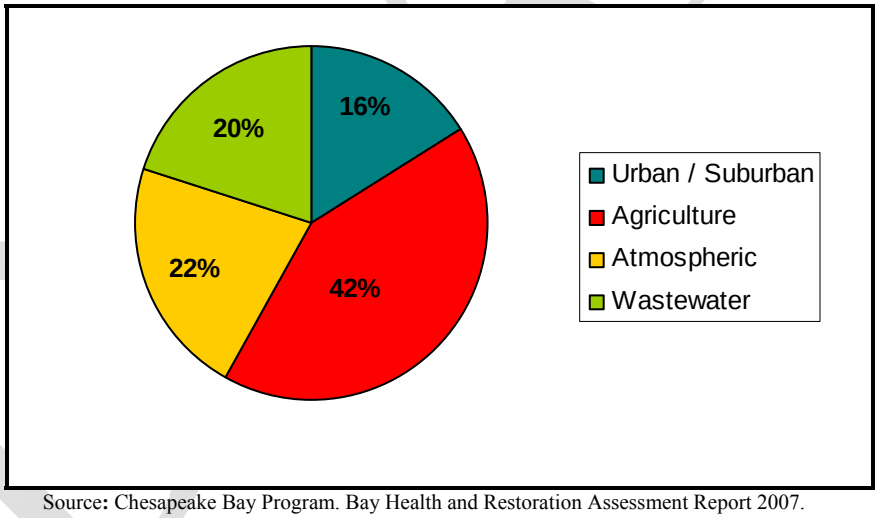
[****] The impairments cited here represent the monitoring activities taking place in the watershed and may not reflect the complete condition of the watershed.

Since 1983, the Chesapeake Bay Program has been a pioneer in coordinating both interstate and federal cooperation to set, and strive towards, goals of reduced pollution and increased restoration. In 2000, the Chesapeake Executive Council signed an agreement between several of the Chesapeake Bay states that set comprehensive pollution reduction goals for the year 2010. Though several subsequent conservation efforts have had relative success, the overall health of the Chesapeake Bay continues to decline.[92]

In order to standardize the evaluation of the Chesapeake Bay watershed, the following four pollution indicators are commonly employed: nitrogen, phosphorus, sediment, and chemical contaminants. Though most water quality monitoring sites have noted a decrease in nitrogen and phosphorus concentrations throughout the watershed in recent years, the rate of decline is far too slow to achieve the nutrient reduction goals set for 2010.[93]

During the 2007 water year, defined by the twelve month period between October and September, 318 million pounds of nitrogen reached the Bay.[94] The biggest factor contributing to nitrogen load is agriculture, responsible for more than 40 percent of the entire nitrogen load (Figure 5-3).[95] Agricultural sources include, for example, manure land application and chemical fertilizer. Other major sources of nitrogen in the Chesapeake Bay are municipal and industrial wastewater, urban and suburban lands, and atmospheric deposition from sources such as vehicles, industry, and livestock in the form of ammonia.[96] Ammonia makes up nearly a third of total nitrogen emissions ending up in the Bay, with agriculture contributing 80 percent of that ammonia.[97]

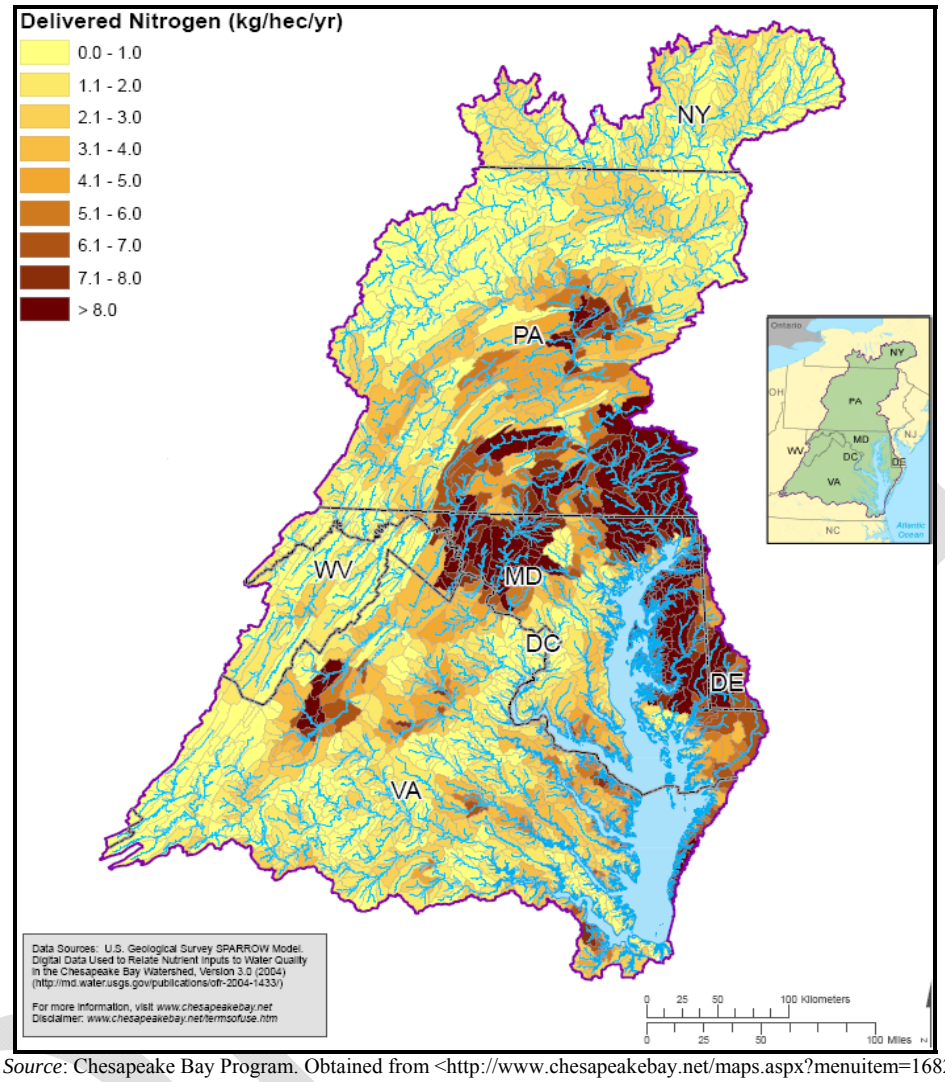
Figure 5-3: Sources of Nitrogen to the Chesapeake Bay (2007)



Source: Chesapeake Bay Program. Bay Health and Restoration Assessment Report 2007.

The Chesapeake Bay Program utilized the USGS Spatially Referenced Regressions On Watershed (SPARROW) model to spatially relate the agricultural sources of locally generated nitrogen to hydrologic attributes of the watershed. The highest sources of nitrogen are represented in Figure 4. The areas with some of the highest delivered yield of agricultural nitrogen are the Maryland Eastern Shore, Potomac, and Lower East Susquehanna tributary basins.

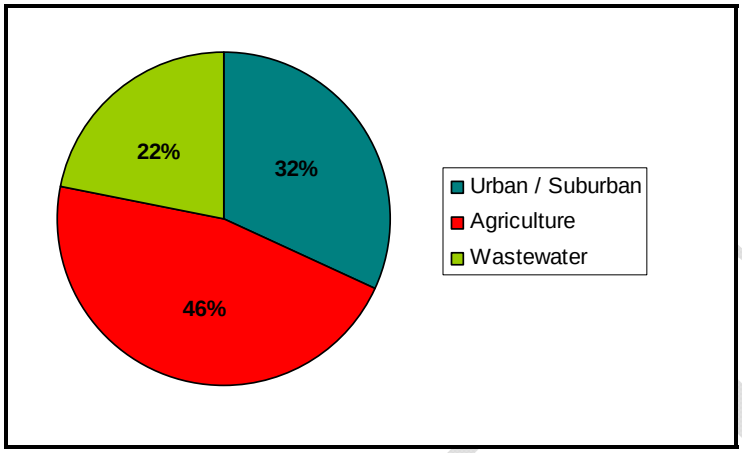
Figure 5-4: Agricultural Sources of Nitrogen



Source: Chesapeake Bay Program. Obtained from <http://www.chesapeakebay.net/maps.aspx?menuitem=16828>

Phosphorus is another nutrient of concern in the Chesapeake Bay watershed. An estimated 15 million pounds of phosphorus reached the Bay during the 2007 water year.[98] Agricultural sources contribute almost half of all phosphorus entering the Bay. Other sources include urban and suburban lands contributing fertilizer and sediment, and wastewater from municipal and industrial discharge (Figure 5-5).

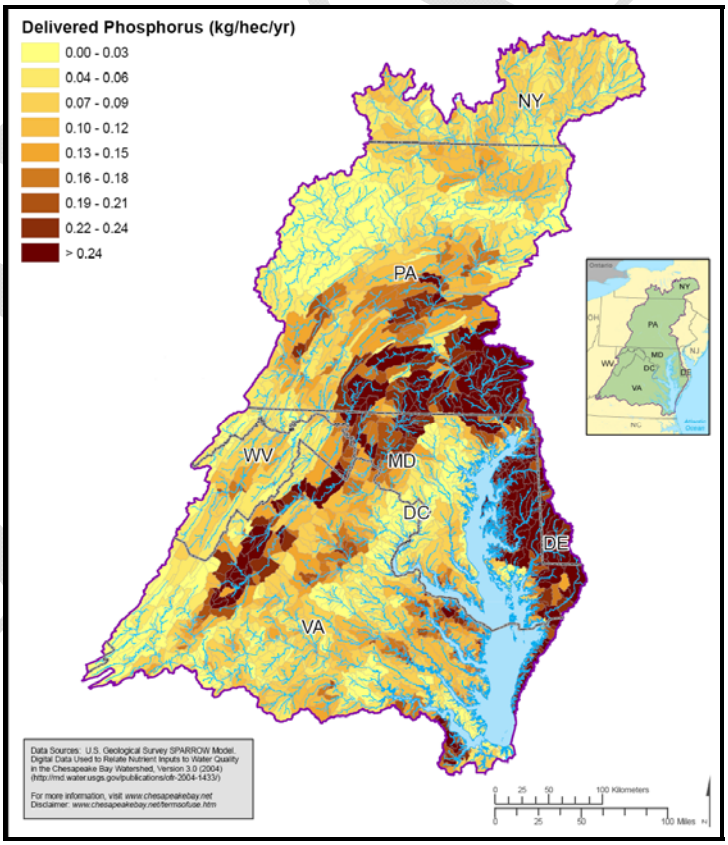
Figure 5-5: Sources of Phosphorus to the Chesapeake Bay (2007)



Source: Source**:** Chesapeake Bay Program. Bay Health and Restoration Assessment Report 2007.

A SPARROW-generated representation of agricultural sources of phosphorus coupled with watershed characteristics indicates that the areas delivering the majority of excess phosphorus into the watershed are concentrated on the eastern shore of the basin, as well as the lower east Susquehanna and the mid-western portions of the Potomac, Rappahannock, and James tributary basins (Figure 5-6).

Figure 5-6: Agricultural Sources of Phosphorus



Source: Chesapeake Bay Program. Obtained from <http://www.chesapeakebay.net/maps.aspx?menuitem=16828>

Sediment is another major pollutant in the watershed, increasing turbidity and contributing to the excess nutrients in the Bay. According to the Chesapeake Bay Program, agricultural activity is responsible for almost three quarters of the Chesapeake Bay's total sediment load.[99]

The Chesapeake Bay states' Clean Water Act Section 303(d) Threatened and Impaired Waters Lists, which list waterbodies that are impaired or are threatened to be impaired by pollutants, have almost 3,000 waterbodies listed for the Chesapeake Bay watershed. The Chesapeake Bay states' 305(b) National Water Quality Inventory Reports, which disclose conditions of all assessed waterbodies in each state, including causes of impairment from types of pollution and likely sources of pollution, has 3,946 waterbodies listed as "impaired" in the Chesapeake Bay watershed (Table 5-9).[100]

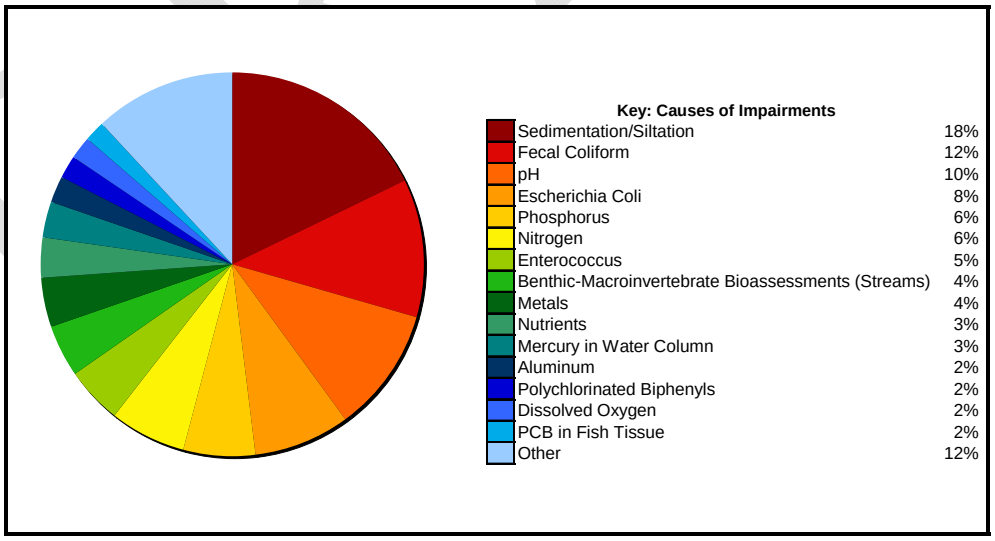
Table 5-9: Number of Waterbodies Assessed and Impairment Status of the Waterbodies in the Chesapeake Bay Watershed

	Good		Impaired		Total Assessed	Not Assessed
Sub-Watershed	**#**	**%**	**#**	**%**		
Susquehanna River	3,360	70	1,474	30	4,834	12
Upper Chesapeake	227	34	441	66	668	554
Potomac	1,036	51	1,015	49	2,051	787
Lower Chesapeake	471	32	1,016	68	1,487	593

Source: EPA Assessment TMDL Tracking and Implementation System (ATTAINS) database for 2006. Data obtained from <http://iaspub.epa.gov/waters10/attains_index.control?p_area=NC> Accessed on July 21, 2008.
Note: 303(d) data presented correspond to the 2006 reporting cycle for MD, DE, NY, WV, VA, and DC. The 303(d) 2004 reporting year was used for PA as the electronic version has not been submitted to EPA.

The most prevalent causes of impairment in the Chesapeake Bay watershed are attributed to sediment, pathogens, pH, and nutrients (Figure 5-7).[101]

Figure 5-7: 305(b) Causes of Impairments as a Percent of Total Miles Assessed (2006)



Source: EPA ATTAINS database for 2006. Accessed on July 21, 2008.

The types of impairments within each of the four different sub-watersheds appear to be representative of various land uses and industrial activities. While waterbodies in the Susquehanna and the Upper Chesapeake sub-watersheds experience more problems with sedimentation and nutrients, respectively, waterbodies in the Potomac and Lower Chesapeake sub-watersheds seem to be suffering more from pathogen related impairments (Table 5-10).[102]

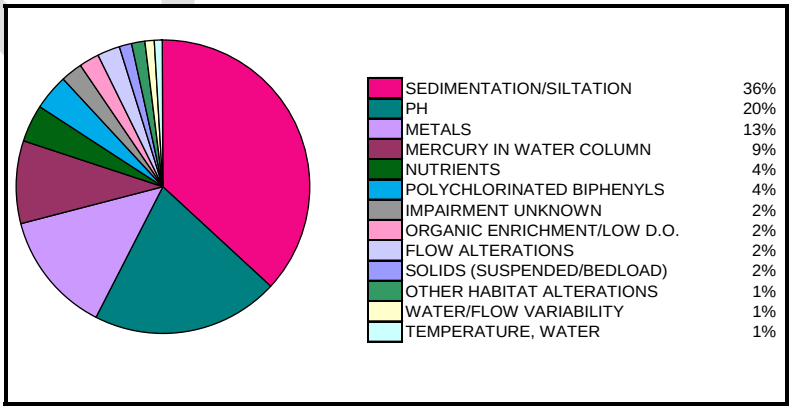
Table 5-10: Summary of 305(b) Top Impairments by Watershed (4-Digit HUC Level)

Impairments	Percent of Total Impairments
Susquehanna River	
Sedimentation / Siltation	36
pH	20
Metals	13
Mercury in Water Column	9
Upper Chesapeake	
Phosphorus (Total)	33
Nitrogen (Total)	33
Enterococcus	25
Habitat Assessments (Streams)	2
Potomac	
Fecal Coliform	27
Benthic-Macroinvertebrate Bioassessments (Streams)	16
Escherichia Coli	12
Aluminum	10
Lower Chesapeake	
Fecal Coliform	32
Escherichia Coli	30
pH	13
Oxygen, Dissolved	9

Source: EPA ATTAINS database for 2006. Accessed on July 21, 2008.

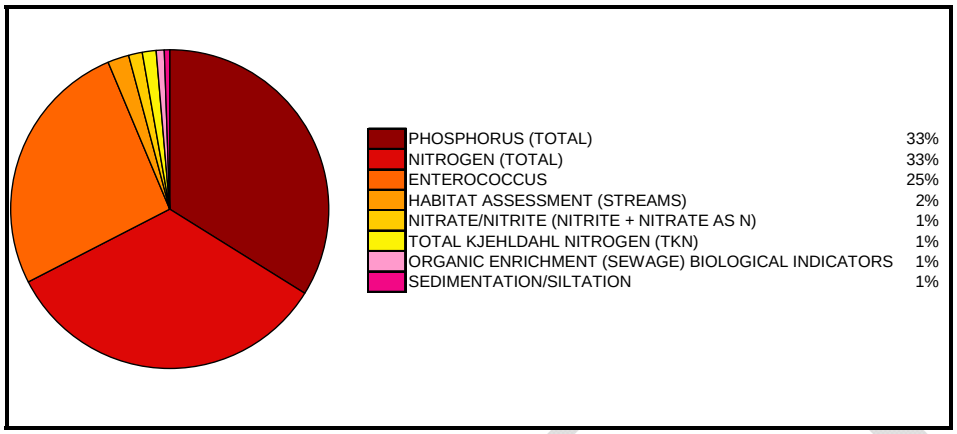
Figure 5-9 through Figure 5-12 portray the top causes of impairments and associated impairment patterns in each of the four sub-watersheds of the region.[103]

Figure 5-9: Top Causes of Impairments of 305(b) Waterbodies in the Susquehanna River Sub-Watershed (HUC 0205)



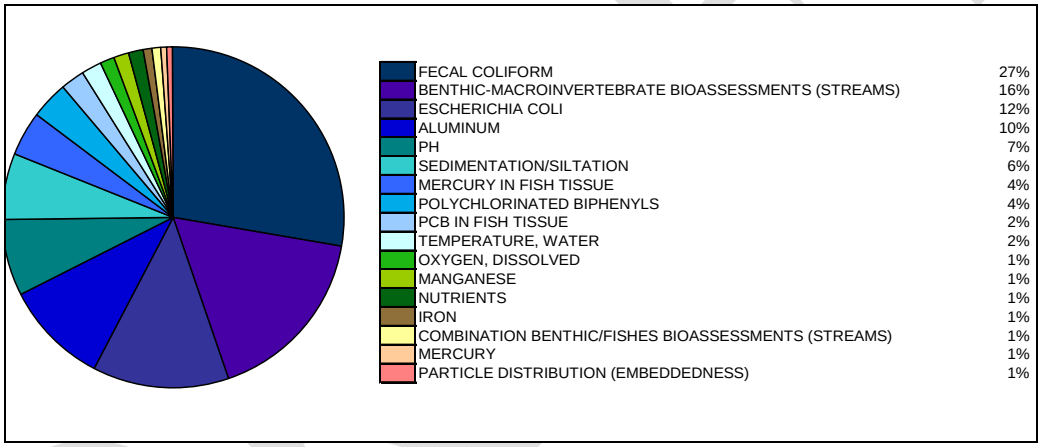
Source: EPA ATTAINS database for 2006. Accessed on July 21, 2008.

Figure 5-10: Top Causes of Impairments of 305(b) Waterbodies in the Upper Chesapeake Sub-Watershed (HUC 0206)



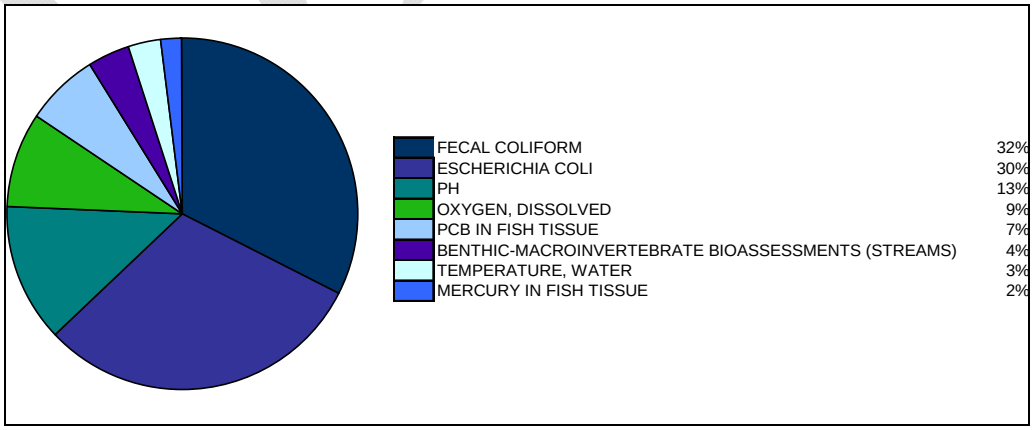
Source: EPA ATTAINS database for 2006. Accessed on July 21, 2008.

Figure 5-11: Top Causes of Impairments of 305(b) Waterbodies in the Potomac Sub-Watershed (HUC 0207)



Source: EPA ATTAINS database for 2006. Accessed on July 21, 2008.

Figure 5-12: Top Causes of Impairments of 305(b) Waterbodies in the Lower Chesapeake Sub-Watershed (HUC 0208)



Source: EPA ATTAINS database for 2006. Accessed on July 21, 2008.

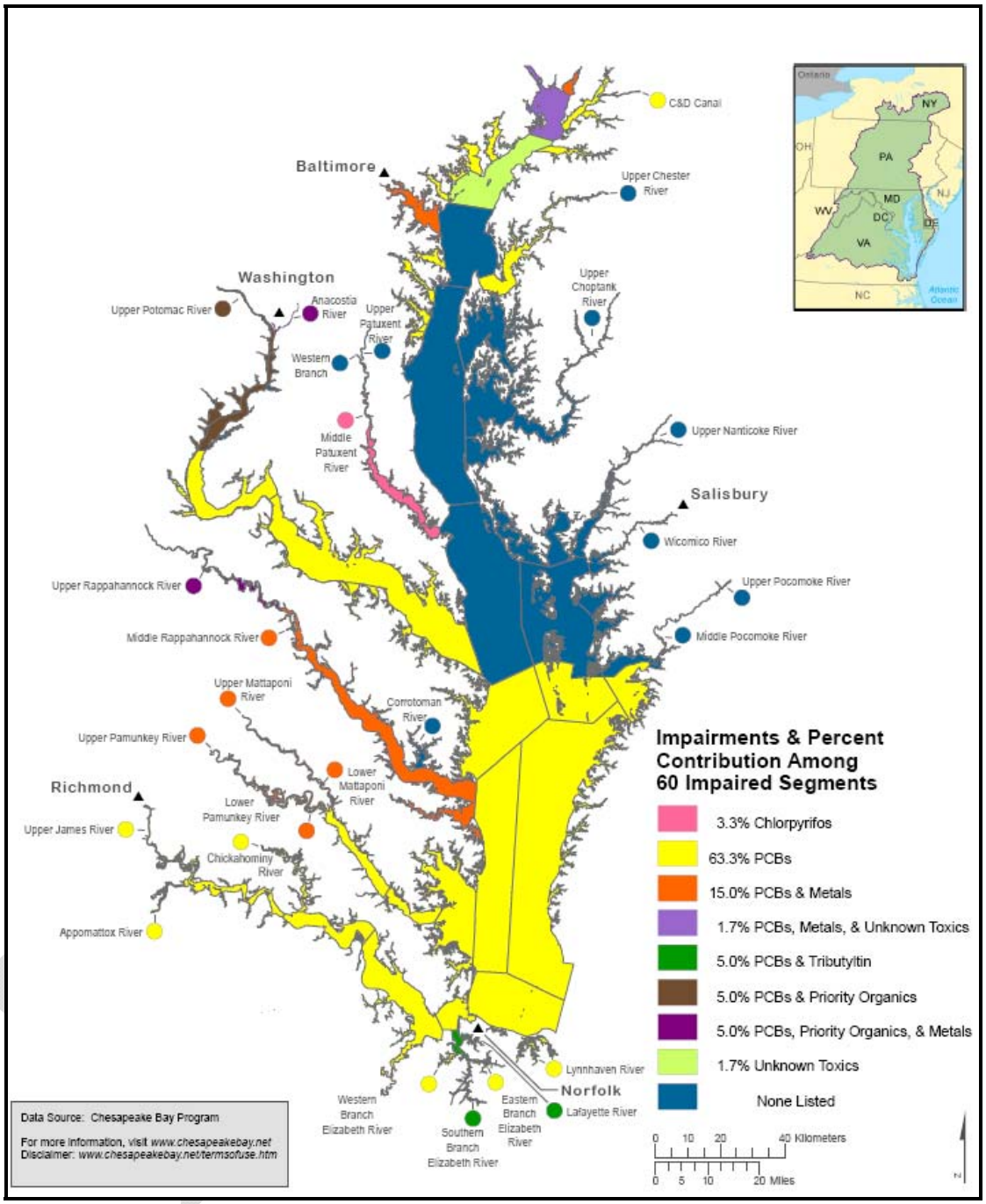
Chemical contaminants such as pesticides and metals have also proven to be of major concern throughout the watershed. Common sources of toxic chemicals include stormwater, wastewater, and air pollution.[104] The most common metal found in the watershed is mercury. According to the 2007 scientific synthesis report by the USGS, low levels of synthetic organic pesticides and their degradation products have been detected throughout the watershed.[105] Based on research in the Potomac River Basin and the Delmarva Peninsula, it was discovered that while pesticides like atrazine, metolachlor, and simazine were more commonly detected in surface water, atrazine was the main pesticide detected in ground water.[106] Though concentrations of pesticides such as organochlorine pesticides (e.g., DDT) have declined slightly since the 1970's, concentrations of PCBs have remained virtually unchanged.

After an extensive sampling study conducted by the USGS and the Virginia Department of Environmental Quality, low levels of persistent hydrophobic contaminants, legacy pesticides, and PCBs were detected, indicative of a largely agricultural land use. Atrazine was the most common pesticide that was detected. A number of other chemicals were detected in the Shenandoan and James River Basins such as galaxolide, indole, and tonalide, which typically come from wastewater dischargers. Significant traces of caffeine, nicotine, prescription pharmaceuticals, natural and synthetic hormones, and estrogenic chemicals were also detected.[107]

Pharmaceuticals and hormones are emerging chemical contaminants with significantly severe repercussions. The health of fish and bird populations is often a good indicator of the overall health of a watershed. Recent research indicates that large populations of fish, particularly male bass, have testicular oocytes, a condition where female eggs grow in the testes, often refereed to as intersex. In the Shenandoah and James River Basins, a high incidence of fish kills, fish exhibiting external lesions and intersex has been observed.[108]

Figure 13 portrays the watershed's tidal waters that are impaired for part or all of the indicated Bay segment due to contamination by toxic chemicals based on each states implementation of the Clean Water Act. Out of the 89 segments portrayed, 60 (67 percent) contain some level of impairment due to toxics (Figure 5-13).[109]

Figure 5-13: Tidal Waters of the Chesapeake Bay Watershed that Are Impaired by Toxic Chemicals



Source: Chesapeake Bay Program. Obtained from <http://www.chesapeakebay.net/maps.aspx?menuitem=16828>

Water Quality Monitoring Stations

A large number of organizations routinely monitor water quality in the Chesapeake Bay watershed. While various organizations focus their monitoring efforts on particular pollutants, most report to EPA's Storage and Retrieval Data Warehouse (STORET). STORET is a data management system containing water quality information for the nation's

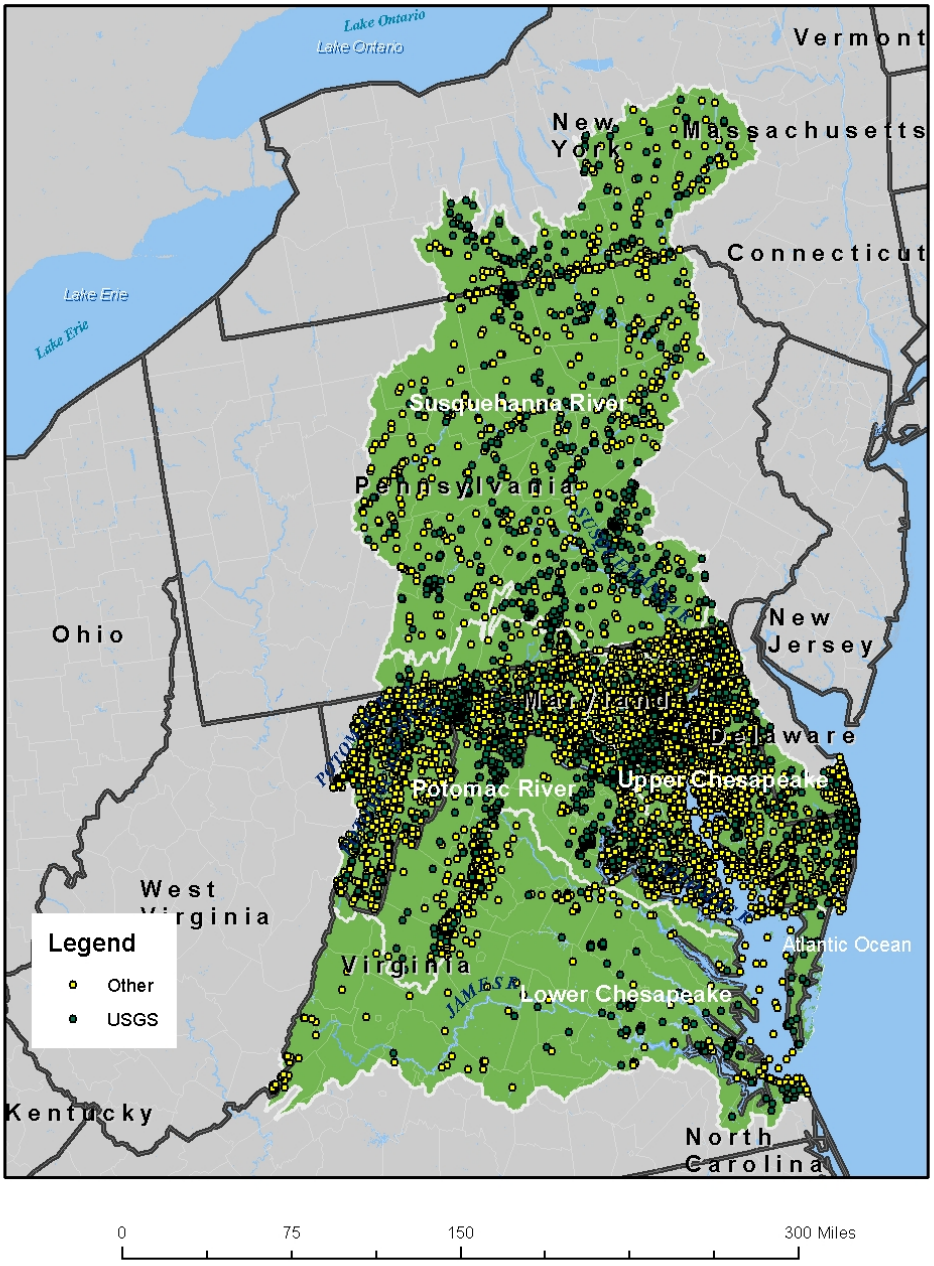
waters. In the Chesapeake Bay watershed, almost two dozen state and regional organizations report water quality data to the STORET database. The USGS National Water Information System stores water quality data of more than 1.5 million sites throughout the country and conducts monitoring for the entire spectrum of impairments as well as quantity, distribution, and movement of water parameters. In the Chesapeake Bay watershed, the USGS has the most stations at 2,496, with almost half located in the Lower Chesapeake sub-watershed. The Upper Chesapeake sub-watershed has the largest number of stations, with the state of Maryland providing a significant amount of data and resources for monitoring efforts (Table 5-11, Figure 5-13).

Table 5-11: Number of Water Quality Monitoring Stations in the Chesapeake Bay Watershed

	Sub-Watersheds				Total Chesapeake Watershed
	Susquehanna River	**Upper Chesapeake**	**Potomac River**	**Lower Chesapeake**	
DE Dept. of Natural Resources and Environmental Control	-	56	-	-	**56**
DE Dept. of NREC	-	16	-	-	**16**
Division of Water and Waste Management (WV)	-	1	653	28	**682**
Environmental Monitoring and Assessment Program	-	72	7	31	**110**
EPA National Aquatic Resource Survey Data (NARS)	22	12	16	32	**82**
Keystone Watershed Monitoring Network (PA)	4	-	-	-	**4**
MD Dept. of Environment Beaches Data	2	955	77	-	**1,034**
MD Department of Natural Resources Data	37	467	365	-	**869**
MD Dept. of the Environment Dredging Ambient Data	-	268	-	-	**268**
MD Dept. of the Environment Shellfish Data	-	588	111	7	**706**
MD Dept. of the Environment Risk Assessment Data	1	139	89	-	**229**
MD Dept. of the Environment Toxics Data	-	285	3	4	**292**
MD Dept. Environment In House Water Data	64	938	494	-	**1496**
MD Dept. of the Environment Private Pier Aquaculture Program	-	209	20	-	**229**
National Park Service	13	18	475	406	**912**
NYS Dept. of Environmental Conservation, Division of Water	23	-	-	-	**23**
PA Dept. of Environmental Protection	113	1	6	-	**120**
Potomac Appalachian Trail Club Volunteer Monitoring - VA, MD	1	-	-	-	**1**
Private Groups, Local Subdivision Data	-	164	34	-	**198**
Susquehanna River Basin Commission	627	-	-	-	**627**
USGS	498	327	480	1,191	**2,496**
VA Department of Health	-	1	4	37	**42**
Totals	**1,405**	**4,517**	**2,834**	**1,736**	**10,492**

Source: USGS National Water Information System. EPA's STORET.
Note: Monitoring stations active between 2002 to present, with at least one type of water quality parameter tested at the site.

Figure 5-13: Monitoring Stations in the Chesapeake Bay Watershed



Source: USGS National Water Information System database. EPA's STORET.
Note: Monitoring stations active between 2002 to present, with at least one type of water quality parameter tested at the site.

Studies and Initiatives

To counter the degradation that persists in the Chesapeake Bay watershed, local, regional, state, and federal organizations have come together in various efforts to reduce pollution and increase awareness and restoration efforts. In May of 2007, the U.S. Department of Agriculture and EPA publically announced an enhanced framework of coordination to achieve nutrient reduction in the sub-watersheds of the Chesapeake Bay

watershed.[110] For years, the U.S. Department of Agriculture 's Natural Resource Conservation Service has been providing technical assistance to farmers helping to plan and incorporate conservation practices such as planting stream buffers, fencing cattle out of streams, and proper manure management throughout the watershed. Because of various programs and incentives set by the Natural Resource Conservation Service, proper nutrient and crop residue management, along with proper pest management, have been applied to thousands of acres in the watershed between 2002 and 2004 (Table 5-12).[111]

Table 5-12: Performance Figures in the Chesapeake Bay Watershed (2002-2004)

Conservation Measure	Applied
Conservation Buffers	54,000 acres
Crop Residue Management	222,000 acres
Nutrient Management	630,000 acres
Pest Management	168,000 acres
Wetlands Created, Restored, Enhanced	8,000 acres
Comprehensive Nutrient Management Plans	1,200 plans
Farmland Protected	83,000 acres

Source: U.S. Department of Agriculture Natural Resource Conservation Service Conservation Resource Brief: Chesapeake Bay and Agriculture. October 2006.

Another major player in the conservation efforts of the Chesapeake Bay is the Chesapeake Bay Program, originally formed in 1983. The Chesapeake Bay Program has extensive research, monitoring, and modeling resources, and has established itself as the official authority on the issues concerning the Chesapeake Bay.

The Chesapeake Bay Program initiated the Chesapeake 2000 Agreement, under which governors of the Chesapeake Bay states, the Chesapeake Bay Commission, and EPA set goals for pollution reduction and best management practice (BMP) implementation for the year 2010. Although agriculture has made significant strides towards the goals set in 2000, the rate of pollution reduction control implementation seems to be too slow to achieve the pollution reduction goals set for 2010.[112] Pollution entering the watershed from urban and suburban lands continues to pose significant and growing problems for the Chesapeake Bay and its vast watershed (Table 5-13).[113]

Table 5-13: Percent of 2010 Goal Achieved by Pollution Control from Agricultural and Urban Sources (2007)

Pollutant	% of Goal Achieved
Agricultural Pollution Controls	
Nitrogen	48%
Phosphorus	51%
Sediment	48%
Urban/Suburban Pollution Controls	
Nitrogen	-83%
Phosphorus	-73%
Sediment	-62%

Source: Chesapeake Bay Program. 2007 Health and Restoration Assessment.

Among the Program's key resources are its modeling capabilities which include the following three models, the Watershed Model, the Estuary Model and the Airshed Model. The Watershed Model, the latest version of which is Phase 5, can be used on a very fine scale to aid in state-level development of Total Maximum Daily Loads

(TMDL)[††††] as well as overall assessments of the water quality in the watershed. Other simulations which can be performed with the models include land use, BMP implementation, nutrient loads, and aerial deposition.[114] The development of the models requires a significant degree of collaboration between the Chesapeake Bay Program, federal, state, and regional organizations such as EPA, USGS, the Interstate Commissions on the Potomac River Basin, and the Maryland Department of the Environment.

The USGS has played a critical role in providing key information and scientific analysis for the Chesapeake Bay Program since its formation in the 1980's. The USGS developed SPARROW models that are capable of providing finer resolution of pollution sources and their transport through the watershed into the Chesapeake Bay, allowing for a greater level of precision in planning and resource management. Recently, the USGS has selected Morgan Creek, located in Maryland on the Delmarva Peninsula, as one of five watersheds to be studied in order to understand how natural factors and agricultural management practices affect the transport of water and chemicals. The watershed was chosen due to its natural setting, its primary crop production of corn and soybeans, and the pollutants detected in past studies such as high levels of herbicides and nitrates.[115] This "Agriculture Chemicals: Sources, Transport and Fate" study is part of the USGS National Water Quality Assessment Program in which Morgan Creek is further assessed as part of the Potomac River Basin and Delmarva Peninsula study unit. The USGS has conducted various studies in the 13,265,920 acre study unit including surface and groundwater assessments, land use assessments, and aquifer and mercury studies.[116]

Table 5-14 summarizes other local, regional, state, and federal programs and coalitions striving to conserve and improve the water resources of the region.

[††††] A Total Maximum Daily Load (TMDL) is a regulatory term in the U.S. Clean Water Act, describing a value of the maximum amount of a pollutant that a body of water can receive while still meeting water quality standards.

Table 5-14: Selected Initiatives and Studies

Organization	Initiative/ Study Name	Description / Findings
U.S. Department of Agriculture Natural Resource Conservation Service	Environmental Quality Incentives Program: Conservation Innovation Grant[117]	▪ The Chesapeake Bay watershed has been awarded $5 million for fiscal year 2008 to fund 11 innovative projects in the 6-state region to protect water quality, recycle nutrients, and improve wildlife habitat. ▪ Some of the largest grant allocations have been awarded to the following organizations: o Virginia Polytechnic Institute and State University o West Virginia University Research Corp. o American Farmland Trust o University of Pennsylvania o University of Delaware o Chesapeake Bay Foundation, Inc.
Chesapeake Bay Program and USGS	Chesapeake Online Assessment Support Tools	▪ A web-based decision support tool meant to enhance implementation, help the objectives of the Chesapeake Action Plan's water quality goal, and aid federal, state, local governments, and NGOs in implementing watershed management actions. ▪ The model will include tools to select areas for implementation, choose most effective actions, monitor water quality response, and better understand factors to adjust actions.
Chesapeake Bay Foundation	Resource Protection Program	▪ The Program has the 3 following focuses: o Protecting Natural Resources o Restoring Habitat o Inspiring and Engaging Volunteers
Alliance for the Chesapeake Bay	Forestry for the Bay	▪ A voluntary program for small- and medium-sized landowners interested in actively conserving or restoring their woodland property.
USGS	Chesapeake Bay Land Change Model	▪ Model will serve as a prototype for a National Land Change Community Modeling system ▪ Model will link the Chesapeake Bay Program watershed model to predict nutrient and sediment loads through the year 2030.
U.S. Department of Agriculture Natural Resource Conservation Service	Conservation Security Program	▪ A voluntary program that provides financial and technical assistance to promote the conservation and improvement of soil, water, air, energy, plant and animal life, and other conservation purposes on Tribal and private working lands. ▪ Chesapeake Bay Basin watersheds participating in the program include Nanticoke (DE), Lower Rappahannock, Mattaponi, South Fork Shenandoah, North Fork Shenandoah (VA), Monocacy, Chester-Sassfras, Choptank, Nanticoke (MD), and Rayston, Lower Susquehanna-Swatara (PA).
U.S. Department of Agriculture	Conservation Effects Assessment Program	▪ The Choptank watershed, located on the Delmarva Peninsula, is one of 24 watershed projects in the program. ▪ The program objectives include detecting differences in nutrient concentrations in basins with similar amounts of agriculture but varying amounts of acres in the Conservation Reserve Enhancement Program, cover crops, and concentrated animal feeding operations; modeling nutrient transport from agricultural areas in the watershed; and determining the effect of land application of poultry litter on streamwater quality.
The National Fish and Wildlife Foundation	Chesapeake Bay Small Watershed Grants	▪ The Program provides grants to organizations and municipal governments working to improve the condition of their local watershed. ▪ Since 2000, the Small Watershed Grants program has provided $20.8 million to support 555 projects throughout the Bay watershed.

Table 5-14: Selected Initiatives and Studies

Organization	Initiative/ Study Name	Description / Findings
National Oceanic and Atmospheric Administration (NOAA)	NOAA Chesapeake Bay Office	▪ The NOAA Chesapeake Bay Office works to help protect and restore the Chesapeake Bay through its programs in fisheries management, habitat restoration, coastal observations, and education, and represents NOAA in the Chesapeake Bay Program.
Chesapeake Community Modeling Program	Chesapeake Bay Regional Ocean Modeling System Community Model	▪ A community ocean modeling system for the Chesapeake Bay region being developed by scientists in NOAA, University of Maryland, Chesapeake Research Consortium, and Maryland Department of Natural Resources supported by the NOAA Monitoring and Event Response for Harmful Algal Blooms Program. ▪ The model is built based on the Rutgers Regional Ocean Modeling System with significant adaptations for the Chesapeake Bay. ▪ The model is developed to provide a community modeling system for nowcast and forecast of 3D hydrodynamic circulation, temperature and salinity, sediment transport, biogeochemical and ecosystem states with applications to ecosystem and human health in the Bay. Model validation is based on Bay-wide satellite remote sensing, real-time in situ measurements and historical data provided by the Chesapeake Bay Program.
Interstate Commission on the Potomac River Basin		▪ The Commission was established by Congress in 1940 to help the Potomac basin states and the federal government enhance, protect, and conserve the water and associated land resources of the Potomac River basin through regional and interstate cooperation. ▪ The representatives of the Commission are from Maryland, Pennsylvania, Virginia, West Virginia, the District of Columbia, and the federal government.
The Chesapeake Research Consortium, Inc.		▪ A non-profit corporation chartered by the State of Maryland. It is an association of six institutions, each with a long-standing involvement in research on problems affecting the Chesapeake Bay and its watershed.

APPENDIX A

Table A-1: Area and HUCs of the Chesapeake Bay Watershed		
HUC	**Watershed Name**	**Area (acres)**
0205	**The Susquehanna River Basin**	
020501	***Upper Susquehanna River***	
02050101	Upper Susquehanna	1,446,400
02050102	Chenango	1,011,200
02050103	Owego-Wappasening	665,600
02050104	Tioga	876,800
02050105	Chemung	768,000
02050106	Upper Susquehanna-Tunkhannock	1,267,200
02050107	Upper Susquehanna-Lackawanna	1,126,400
020502	***West Branch Susquehanna***	
02050201	Upper West Branch Susquehanna	1,017,600
02050202	Sinnemahoning	652,800
02050203	Middle West Branch Susquehanna	491,520
02050204	Bald Eagle	489,600
02050205	Pine	620,800
02050206	Lower West Branch Susquehanna	1,158,400
020503	***Lower Susquehanna***	
02050301	Lower Susquehanna-Penns	915,200
02050302	Upper Juniata	622,720
02050303	Raystown	599,680
02050304	Lower Juniata	928,000
02050305	Lower Susquehanna-Swatara	1,184,000
02050306	Lower Susquehanna	1,561,600
0206	**Upper Chesapeake**	
020600	***Upper Chesapeake***	
02060001	Upper Chesapeake Bay	812,800
02060002	Chester-Sassafras	825,600
02060003	Gunpowder-Patapsco	876,800
02060004	Severn	208,000
02060005	Choptank	595,840
02060006	Patuxent	590,080
02060007	Blackwater-Wicomico	343,680
02060008	Nanticoke	525,440
02060009	Pocomoke	493,440
02060010	Chincoteague	474,880
0207	**The Potomac River Basin**	
020700	***Potomac***	
02070001	South Branch Potomac	953,600
02070002	North Branch Potomac	870,400
02070003	Cacapon-Town	768,000
02070004	Conococheague-Opequon	1,440,000
02070005	South Fork Shenandoah	1,062,400
02070006	North Fork Shenandoah.	665,600

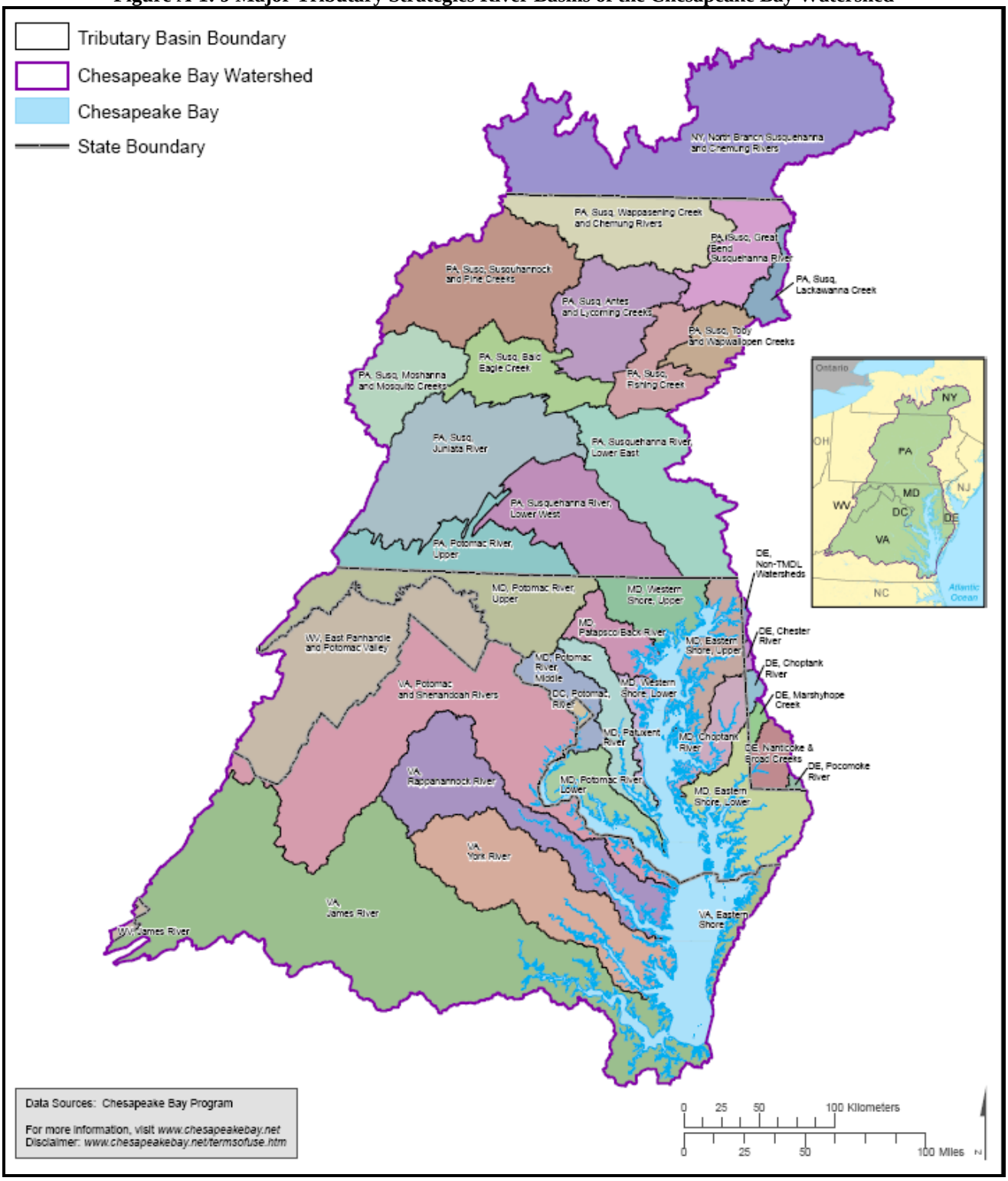
Table A-1: Area and HUCs of the Chesapeake Bay Watershed		
HUC	**Watershed Name**	**Area (acres)**
02070007	Shenandoah	229,760
02070008	Middle Potomac	774,400
02070009	Monocacy	615,680
02070010	Middle Potomac-Anacostia-Occoquan	819,200
02070011	Lower Potomac	1,152,000
0208	**Lower Chesapeake**	
020801	***Lower Chesapeake***	
02080101	Lower Chesapeake Bay	889,600
02080102	Great Wicomico-Piankatank	387,200
02080103	Rapidan-Upper Rappahannock	979,200
02080104	Lower Rappahannock	742,400
02080105	Mattaponi.	576,640
02080106	Pamunkey	928,000
02080107	York	176,000
02080108	Lynnhaven-Poquoson	136,320
02080109	Western Lower Delmarva	216,320
02080110	Eastern Lower Delmarva	292,480
020802	***The James River Basin***	
02080201	Upper James	1,414,400
02080202	Maury	523,520
02080203	Middle James-Buffalo	1,273,600
02080204	Rivanna	485,120
02080205	Middle James-Willis	606,720
02080206	Lower James	921,600
02080207	Appomattox	1,017,600
02080208	Hampton Roads	272,000

Source: USGS. Available at: http://water.usgs.gov/GIS/huc_name.html

Table A-2: Counties of the Chesapeake Bay Watershed, by State					
Virginia	**Pennsylvania**	**Maryland**	**New York**	**West Virginia**	**Delaware**
Accomack	Adams	Allegany	Allegany	Berkeley	Kent
Albemarle	Bedford	Anne Arundel	Broome	Grant	Sussex
Alleghany	Berks	Baltimore	Chemung	Hampshire	
Amelia	Bradford	Calvert	Chenango	Hardy	
Amherst	Cambria	Caroline	Cortland	Jefferson	
Appomattox	Cameron	Carroll	Delaware	Mineral	
Augusta	Centre	Cecil	Herkimer	Morgan	
Bath	Chester	Charles	Madison	Pendleton	
Bedford	Clearfield	Dorchester	Otsego		
Botetourt	Clinton	Frederick	Schuyler		
Buckingham	Columbia	Garrett	Steuben		
Charles City	Cumberland	Harford	Tioga		
Chesapeake City	Dauphin	Howard	Tompkins		
Chesterfield	Elk	Kent			
Clarke	Franklin	Montgomery			
Craig	Fulton	Prince George's			

Table A-2: Counties of the Chesapeake Bay Watershed, by State					
Virginia	**Pennsylvania**	**Maryland**	**New York**	**West Virginia**	**Delaware**
Culpeper	Huntingdon	Queen Anne's			
Cumberland	Juniata	St. Mary's			
Essex	Lackawanna	Somerset			
Fairfax	Lancaster	Talbot			
Fauquier	Luzerne	Washington			
Fluvanna	Lycoming	Wicomico			
Frederick	Mifflin	Worcester			
Goochland	Montour	Baltimore city			
Greene	Northumberland				
Hanover	Perry				
Henrico	Potter				
Highland	Schuylkill				
Isle of Wight	Snyder				
James City	Somerset				
King and Queen	Sullivan				
King George	Susquehanna				
King William	Tioga				
Lancaster	Union				
Loudoun	Wyoming				
Louisa	York				
Madison					
Mathews					
Middlesex					
Nelson					
New Kent					
Northampton					
Northumberland					
Nottoway					
Orange					
Page					
Powhatan					
Prince Edward					
Prince George					
Prince William					
Rappahannock					
Richmond					
Rockbridge					
Rockingham					
Shenandoah					
Spotsylvania					
Stafford					
Suffolk					
Surry					
Virginia Beach City					
Warren					
Westmoreland					
York					

Figure A-1: 9 Major Tributary Strategies River Basins of the Chesapeake Bay Watershed



Neuse River Watershed

Neuse River Watershed Summary	
Area	• ~ 3.8 million acres
Location	• North Carolina • 18 Counties, eventually flowing into Pamlico Sound
Population	• 1.5 million in 2006 • Projected population of almost 2 million by 2020
Land Use	• Mostly dedicated to agriculture and forestland
Agriculture	• ~ 60% of farmland is dedicated to harvesting crops • Soybeans, cotton, and corn account for 70% of total acres harvested • More than 2 million hogs concentrated in Wayne, Greene, Lenoir, and Pitt Counties • More than 560 concentrated animal feeding operations with water discharge permits, 90% of which are swine and hog operations
Food Manufacturing	• 36 federally-regulated food processing facilities, with more than 80% holding major National Pollutant Discharge Elimination System permits • Most common industries include Sausage and Other Meat Products and Animal Feed manufacturing • Large federally-regulated corporations include Case Farms, Smithfield Foods Inc., Cargill, and Southern States Cooperative
Municipalities	• Upper Neuse regions rely heavily on surface water for water supplies, accounting for almost two-thirds of water demand • Watershed has 295 federally-regulated wastewater treatment facilities with almost 60% located in Durham County • 20 wastewater treatment facilities have "major" designations under the National Pollutant Discharge Elimination System
Impairments and Concerns	• Key pollutants detected include an overabundance of nutrients, mercury, fecal coliform, metals, and pesticides • 41 waterbodies listed on the Threatened and Impaired Waters list (303(d)) • 8 waterbodies listed as "impaired" in the Neuse River Watershed Water Quality Inventory Report (305(b)) • 98% of freshwater streams and shorelines are impaired for reasons of biological integrity, low dissolved oxygen, and mercury • More than 70% of impairments are caused by agricultural activities
Studies and Initiatives	• Neuse River Nutrient Sensitive Waters Management Strategy • U.S. Geological Survey National Water Quality Assessment Program Albemarle – Pamlico Study Unit

Introduction

The Neuse River originates in North Carolina's northern Person and Orange counties and runs southeast through 18 counties and 74 municipalities, eventually flowing into the Pamlico Sound.[118] The Neuse River watershed spans an area of almost four million acres and is one of only four watersheds whose boundaries lie completely within the state.[119] It is made up of 14 North Carolina Division of Water Quality (DWQ) delineated subbasins, corresponding to four U.S. Geological Survey (USGS) Neuse River 8-digit hydrologic unit codes (HUCs), and portions of two Pamlico HUCs (see Note). The four Neuse River 8-digit HUCs represent the four sub-watersheds of the region and are the Upper Neuse, the Middle Neuse, Contentnea and the Lower Neuse (see Table 6-1).

Note on Watersheds, Subwatersheds, Basins and Subbasins

The state of North Carolina delineates its watersheds differently from the system used by the Federal government. The North Carolina Department of Environment and Natural Resources (NCDENR) Division of Water Quality (DWQ) utilizes a two-tiered classification system in which the state is divided into 17 major river basins, with each further divided into subbasins identified by a unique numerical code. The Neuse River Basin is the third largest in the state and is comprised of 14 subbasins. Twelve of the subbasins are fully within the U.S. Geological Survey (USGS) 6-digit hydrologic unit code (HUC) which contains the four sub-watersheds of the Neuse River Basin (030202). The sub-watersheds (8-digit HUCs) for this region are as follows: Upper Neuse, Middle Neuse, Contentnea, and Lower Neuse. The other 2 DWQ subbasins are part of the Pamlico 6-digit HUC (030201) and include portions of Pamlico Sound and Bogue-Core Sounds. In compiling data for this report, county, state, and federal data are utilized and differences in geographic scope are noted.

As the River flows into the Lower Neuse sub-watershed, it broadens dramatically at New Bern and becomes a tidal estuary eventually pouring into the Pamlico Sound. This estuary is considered to be one of the most important fish nurseries in the United States. Some major tributaries of the River include the Eno and Flat Rivers, Swift and Crabtree Creeks, Little River, Contentnea Creek, and Trent River.[120] Mostly concentrated in its upper regions, the Neuse River watershed contains 19 major lakes, with the largest one being Falls Lake. This 12,410 acre body of water serves as the water supply for the City of Raleigh and is managed by the U.S. Army Corps of Engineers for flood control. Out of the 19 major lakes in the watershed, six have primary recreation designations, and 14 have a designated use as a drinking water supply.[121]

Table 6-1: Area and HUCs of the Neuse River Watershed

HUC Code	Watershed Name	Area (acres)
030202	**Neuse Basin**	
03020201	Upper Neuse	1,539,840
03020202	Middle Neuse	680,320
03020203	Contentnea	644,480
03020204	Lower Neuse	541,440
030201	**Pamlico**	
03020105	Pamlico Sound	177,280
03020106	Bogue-Core Sounds	215,040

Source: Neuse River Basinwide Water Quality Plan. NCDENR DWQ. July 2002.
Note: Pamlico Sound and Bogue-Core Sounds are only partially contained within the Neuse River Basin and are mostly contained within the Tar-Pamlico Basin (HUC# 030201)

Agriculture

According to the North Carolina Department of Environment and Natural Resources' (NCDENR) 2006 Neuse River Basinwide Assessment Report, most of the land use in the watershed is dedicated to agriculture and forestland.[122] Some of the most agriculturally intensive counties of the watershed are Greene, Wayne, Wilson, and Lenoir Counties, with nearly or more than half of the land being dedicated to farming. On average, more than 60 percent of the land in farms is dedicated to cropland (Table 6-2).

Table 6-2: Land Use in Counties of the Neuse River Watershed (2002)

County	% of County in Neuse River Watershed	Total County Area (acres)	Land in Farms (acres)	Land in Farms as % of Total County Area	Total Cropland (acres)	Cropland as % of Land in Farms	Irrigated Land (acres)	Irrigated Land as % of Total County Area
Carteret	50	332,698	59,755	18	46,573	78	250	0.08
Craven	95	453,395	78,910	17	59,647	76	2,449	0.54
Durham	73	185,805	26,074	14	9,991	38	659	0.35
Franklin	10	314,893	128,412	41	56,608	44	4,449	1.41
Granville	25	339,917	146,544	43	50,217	34	4,008	1.18
Greene	100	169,856	97,857	58	75,833	77	5,158	3.04
Johnston	98	506,784	194,211	38	132,019	68	6,012	1.19
Jones	81	302,003	76,025	25	52,839	70	3,234	1.07
Lenoir	99	255,904	121,520	47	91,972	76	3,915	1.53
Nash	20	345,773	160,187	46	102,819	64	8,378	2.42
Orange	49	255,898	71,010	28	34,770	49	987	0.39
Pamlico	83	215,642	52,340	24	44,968	86	1,574	0.73
Person	32	251,078	95,153	38	41,898	44	2,344	0.93
Pitt	42	417,011	185,776	45	136,799	74	4,943	1.19
Wake	85	532,429	92,803	17	45,826	49	4,616	0.87
Wayne	91	353,645	171,449	48	126,720	74	6,774	1.92
Wilson	81	237,498	114,564	48	84,738	74	3,098	1.30

Source: 2002 Census of Agriculture (U.S. Department of Agriculture).
Note: Beaufort County information is intentionally omitted as less than 2% of the county lies within the watershed boundaries.

Some of the most commonly grown crops in the Neuse River watershed are soybeans, cotton, corn, wheat, and tobacco (Table 6-3). North Carolina is the number one producer of tobacco, accounting for 75 percent of U.S. output with nearly 170,000 acres harvested in 2007.[123] Johnston County, 98 percent of which is located in the Upper Neuse Contentnea sub-watersheds, is the second largest producer of tobacco in the state with more than 350 tobacco farms.[124] In fact, seven out of the top ten tobacco producing counties of North Carolina are in the Neuse River watershed producing about 40 percent of the state's tobacco output.[125]

Table 6-3: Harvested Crops and Livestock Inventory for Counties in the Neuse River Watershed[a] (2002)					
	Upper Neuse	Middle Neuse	Contentnea	Lower Neuse	Total Neuse River Watershed[b]
Crops Harvested (acres)					
All Cotton	78,135	186,084	209,650	96,419	267,290
Barley for Grain	433	(D)	153	(D)	433
Corn for Grain	41,284	82,477	83,257	64,233	135,334
Corn for Silage	4,647	(D)	1,026	(D)	4,647
Forage	69,457	17,163	48,513	5,320	85,830
Land on Orchards	523	155	529	159	733
Oats for Grain	5,490	1,448	6,492	146	6,859
Peanuts for Nuts	63	3,813	6,367	(D)	6,367
Potatoes	26	5	27	3,188	3,219
Sorghum for Grain	35	(D)	35	685	720
Sorghum for Silage	325	(D)	325	(D)	325
Soybeans for beans	160,632	161,819	266,138	91,647	345,350
Sunflower Seeds	105	(D)	99	(D)	105
Sweet Potatoes	14,313	1,080	21,392	26	21,441
Tobacco	38,781	30,046	55,769	11,036	71,023
Vegetables	5,846	3,819	14,988	1,692	16,618
Wheat for Grain	49,036	46,762	64,021	25,969	92,831
Livestock Inventory (number)					
Beef Cows	29,354	2,769	19,623	1,882	37,056
Cattle and Calves	71,456	21,948	55,444	8,519	93,031
Hogs and Pigs	828,757	1,835,871	1,790,183	643,716	2,170,561
Layers	446,400	74,588	922,552	987	1,043,829
Milk Cows	2,997	54	393	61	3,377
Sheep and Lamb	3,654	1,842	3,596	152	5,450

Source: 2002 Census of Agriculture (U.S. Department of Agriculture).
Note: (D) Signifies that data was withheld to avoid disclosing data for individual farms.
[a] The Neuse River Watershed consists of portions of 18 counties. Because the watershed and sub-watershed boundaries differ from county boundaries, the data presented here actually represents a larger area. Beaufort County data is excluded because less than 2% of it lies within the Neuse River Watershed.
[b] The data presented does not add up across sub-watersheds to equal the Total Neuse River Watershed. The Total Neuse River Watershed column is a sum of the 17 county data presented in the 2002 Census of Agriculture. For a list of counties in each sub-watershed see Appendix B, Table B-1.

North Carolina is also the country's second largest hog producer, closely behind Iowa.[126] Together the two states account for 43 percent of U.S. hog production. Wayne County, of which 91 percent lies in the Upper Neuse, Middle Neuse, and Contentnea sub-watersheds of the Neuse River Basin, is the fourth largest hog producer in the state with more than 500,000 animals. Also in the top ten largest hog producing counties in North Carolina are Greene, Lenoir, and Pitt, with 100, 99, and 42 percent of their land area in the watershed, respectively.

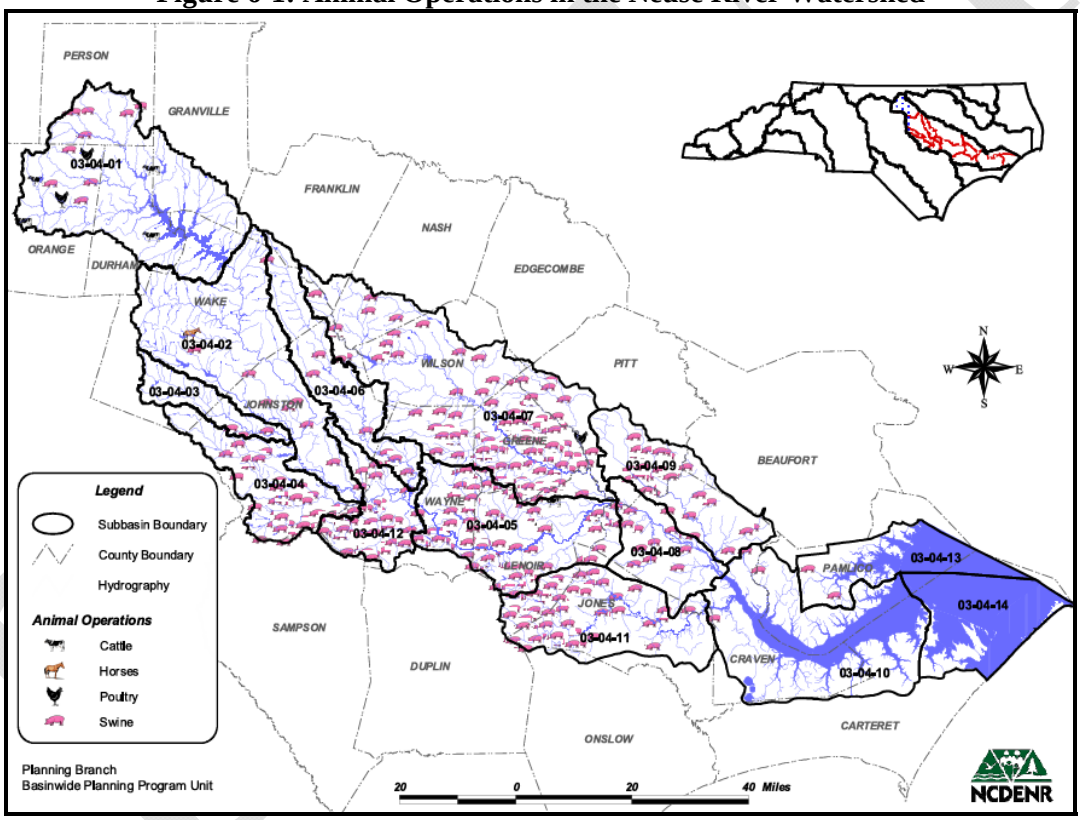
According to NCDENR's 2008 Neuse River Basinwide Water Quality Plan Draft, there are more than 560 animal feeding operations with non-discharge permits in the Neuse River Watershed, more than 90 percent of which are swine and hog operations (Table 6-4, Figure 6-1).

Table 6-4: Permitted Animal Operations in the Neuse River Watershed

Sub-Watershed	Cattle		Poultry		Swine	
	No. of Facilities	No. of Animals	No. of Facilities	No. of Animals	No. of Facilities	No. of Animals
Upper Neuse	14	2,595	1	60,000	195	496,227
Middle Neuse[a]	-	-	2	123,000	58	158,518
Contentnea	2	160	2	276,800	202	645,704
Lower Neuse	-	-	-	-	89	362,331
Pamlico Sound	-	-	-	-	3	1,849
Bogue-Core Sounds	-	-	-	-	-	-
Total	**16**	**2,755**	**5**	**459,800**	**547**	**1,664,629**

Source: Neuse River Basinwide Water Quality Plan. NC Department of Environment and Natural Resources. Division of Water Quality. June 2008.
[a]Data for NCDENR DWQ subbasin 03-04-05 is not available, thus data presented for the Middle Neuse sub-watershed does not represent the entire universe of permitted animal operations within that sub-watershed.
- signifies that data is unavailable

Figure 6-1: Animal Operations in the Neuse River Watershed



Source: Neuse River Basinwide Water Quality Plan. NCDENR, Division of Water Quality Planning. July 2002.
Note: The map portrays the NCDENR sub-basins of the Neuse River Watershed, for corresponding sub-watershed delineations; see Appendix B, Table B-2.

According to the U.S. Department of Agriculture, larger livestock operations are making up an increasingly larger share of the industry. In North Carolina, more than 97 percent of hogs come from farms selling more than 4,000 heads per year.[127] Smithfield Foods Inc. is the largest hog producer in North Carolina and in the country, with a national market share of more than a quarter. Two of its major subsidiaries, Prestage-Stoecker Farms and Premium Standard Farms, the latter of which was acquired by Smithfield in May 2007, are among the largest pork

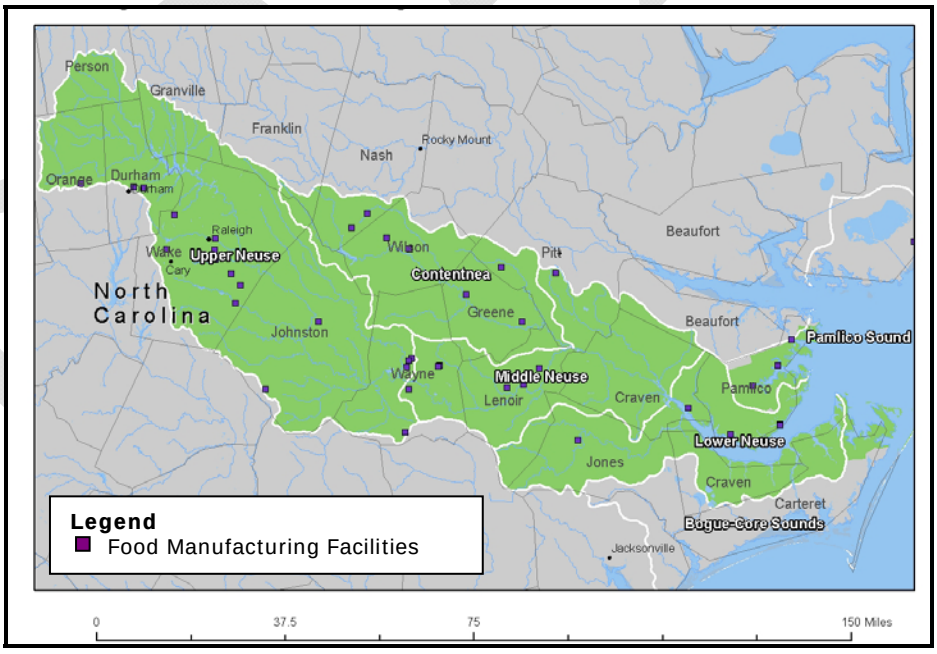
producers in the state. In 2004, Premium Standard Farms produced almost two million hogs in North Carolina, largely in the counties of Pitt and Greene.[128]

Smithfield Foods Inc. utilizes a vertical integration model which incorporates ownership and contractual-based work to achieve maximum control of all aspects of production.[129] In accordance with Smithfield's business philosophy, it does not own the hog farms, but instead provides the animals and feed to farm operators in exchange for the farmers rearing the animals for the market.

Food Manufacturing

EPA data systems show 36 federally regulated food processing facilities in the Neuse River watershed. More than 80 percent hold a National Pollutant Discharge Elimination System (NPDES) water permit (Figure 6-2, Table 6-5). The most common food manufacturing industries include sausages and other meat products animal feed. Almost half of the 36 facilities identified are located in the Upper Neuse watershed. However, many smaller food processing facilities either do not discharge pollutants into waters of the United States and thus do not have NPDES permits or they are "minor" dischargers and are not reported to the federal level. Thus, the data do not include the entire population of food processors in the watershed. In fact, the county-level Census of Manufacturers data for 2002 shows more than 100 establishments in the food manufacturing sector in the counties of the Neuse River watershed, with the Upper Neuse still harboring the majority of the industry (Table 6-6). [130]

Figure 6-2: Food Manufacturing Facilities in the Neuse River Watershed



Source: Data obtained from EPA's Integrated Data for Enforcement Analysis (IDEA) system on July 8, 2008. Query criteria include the following federal permits and identifiers: NPDES water permits, Clean Air Act air permits, Resource Conservation and Recovery Act hazardous waste IDs, and Toxic Release Inventory reporters between 2004 and 2006.

Table 6-5: Federally Regulated Food Product Facilities in the Neuse River Watershed

	SIC Code Industry Description	Facility Name	City / County	NPDES Water Permit (Y/N)
Upper Neuse	2013: Sausages and Other Prepared Meat Products	Goodmark Foods, Inc.	Garner / Wake	Yes
	2026: Fluid Milk	Land O Sun Dairies, Inc.	Goldsboro / Wayne	Yes
	2035: Pickled Fruits and Vegetables, Vegetable Sauces and Seasonings, and Salad Dressings	Mount Olive Pickle Co. Inc.	Mount Olive / Wayne	Yes
	2045: Prepared Flour Mixes and Doughs	Domino's Pizza Distribution	Garner / Wake	Yes
	2048: Prepared Feeds and Feed Ingredients for Animals and Fowls, Except Dogs and Cats	Southern States Feed Mill	Durham / Durham	Yes
		Townsend Farms, Inc.	Bonlee / Chatham	Yes
		Mule City Specialty Feeds Incorporated	Benson / Johnston	Yes
		Atlantic Coast Protein Corporation	Selma / Johnston	No
	2051: Bread and Other Baked Goods except Cookies	Krispy Kreme Doughnut-Wake	Raleigh / Wake	Yes
		Bakery Feeds Incorporated	Durham / Durham	Yes
		Franklin Baking	Goldsboro / Wayne	Yes
	2052: Cookies and Crackers	Austin Foods	Cary / Wake	Yes
	2075: Soybean Oil Mills	Cargill Incorporated	Raleigh / Wake	Yes
	2086: Bottled and Canned Soft Drinks and Carbonated Water	Pepsi Cola Bottling Co.	Raleigh / Wake	Yes
	2097: Manufactured Ice	Triangle Ice Co Incorporated	Raleigh / Wake	Yes
	2099: Food Preparations, NEC	Ej Cox Company Roasting Plant	Clarkton / Bladen	No
Middle Neuse	2013: Sausages and Other Prepared Meat Products	Smithfield Packing Company Incorporated	Kinston / Lenoir	Yes
		Smithfield Kinston 2 Facility	Kinston / Lenoir	Yes
	2015: Poultry Slaughtering and Processing	Case Farms-Processing Plant	Dudley / Wayne	Yes
		Carolina Classics Catfish Incorporated	Greenville / Pitt	Yes
	2048: Prepared Feeds and Feed Ingredients for Animals and Fowls, Except Dogs and Cats	PCS Phosphate Company Incorporated Kinston Division	Kinston / Lenoir	Yes

Table 6-5: Federally Regulated Food Product Facilities in the Neuse River Watershed

	SIC Code Industry Description	Facility Name	City / County	NPDES Water Permit (Y/N)
		Goldsboro Milling Company	Goldsboro / Wayne	Yes
		Case Farms-Feedmill	Goldsboro / Wayne	Yes
Contentnea	2013: Sausages and Other Prepared Meat Products	Smithfield Packing	Wilson / Wilson	Yes
	2041: Flour and Other Grain Mill Products	Glover Milling Company Incorporated	Bailey / Nash	No
		House Autry Mills Incorporated	Four Oaks / Johnston	Yes
	2048: Prepared Feeds and Feed Ingredients for Animals and Fowls, Except Dogs and Cats	Cargill Incorporated Animal Nutrition Division	Wilson / Wilson	Yes
		Bailey Feed Mill Inc	Bailey / Nash	No
		Hubbard Feeds Incorporated	Selma / Johnston	Yes
		Southern States Farmville Feed	Farmville / Pitt	Yes
	2086: Bottled and Canned Soft Drinks and Carbonated Water	Cott Beverages USA Inc.	Wilson / Wilson	Yes
Lower Neuse	2026: Fluid Milk	Maola Milk & Ice Cream Co. Inc.	New Bern / Craven	Yes
	2048: Prepared Feeds and Feed Ingredients for Animals and Fowls, Except Dogs and Cats	Case Farms Limited Liability Company - Grain/Tren	Trenton / Jones	No
	2092: Prepared Fresh or Frozen Fish and Seafoods	Garland F Fulcher Seafood	Oriental / Pamlico	Yes
		Fulcher's Point Pride Seafood	Oriental / Pamlico	Yes
		Holland Seafood	Arapahoe / Pamlico	Yes

Source: Data obtained from EPA's IDEA system on July 8, 2008. Query criteria include the following federal permits and identifiers: NPDES permits, Clean Air Act air permits, Resource Conservation and Recovery Act hazardous waste IDs, and Toxic Release Inventory reporters between 2004 and 2006.

Table 6-6: Number of Food Manufacturing Establishments in the Counties of the Sub-Watersheds of the Neuse River Watershed

Sub-Watershed	Number of Food Manufacturing Establishments
Upper Neuse	79
Middle Neuse	30
Contentnea	87
Lower Neuse	12
Total Neuse River Watershed	**114**

Source: U.S. Census Bureau. Economic Census of Manufacturing. 2006 County Business Patterns. North American Industry Classification System code 311.
Note: The Neuse River Watershed consists of portions of 18 counties. Because the watershed and sub-watershed boundaries differ from county boundaries, the data presented here actually represent a larger area. Beaufort County data is excluded because less than 2% of it lies within the Neuse River watershed. Because the counties of the sub-watersheds overlap amongst each other, the data presented does not add up across sub-watersheds to equal the Total Neuse River Watershed. The Total Neuse River Watershed row is a sum of the 17 county data presented in the U.S. Census Bureau 2006 County Business Patterns. For a list of counties in each sub-watershed see Appendix B, Table B-1.

Municipalities

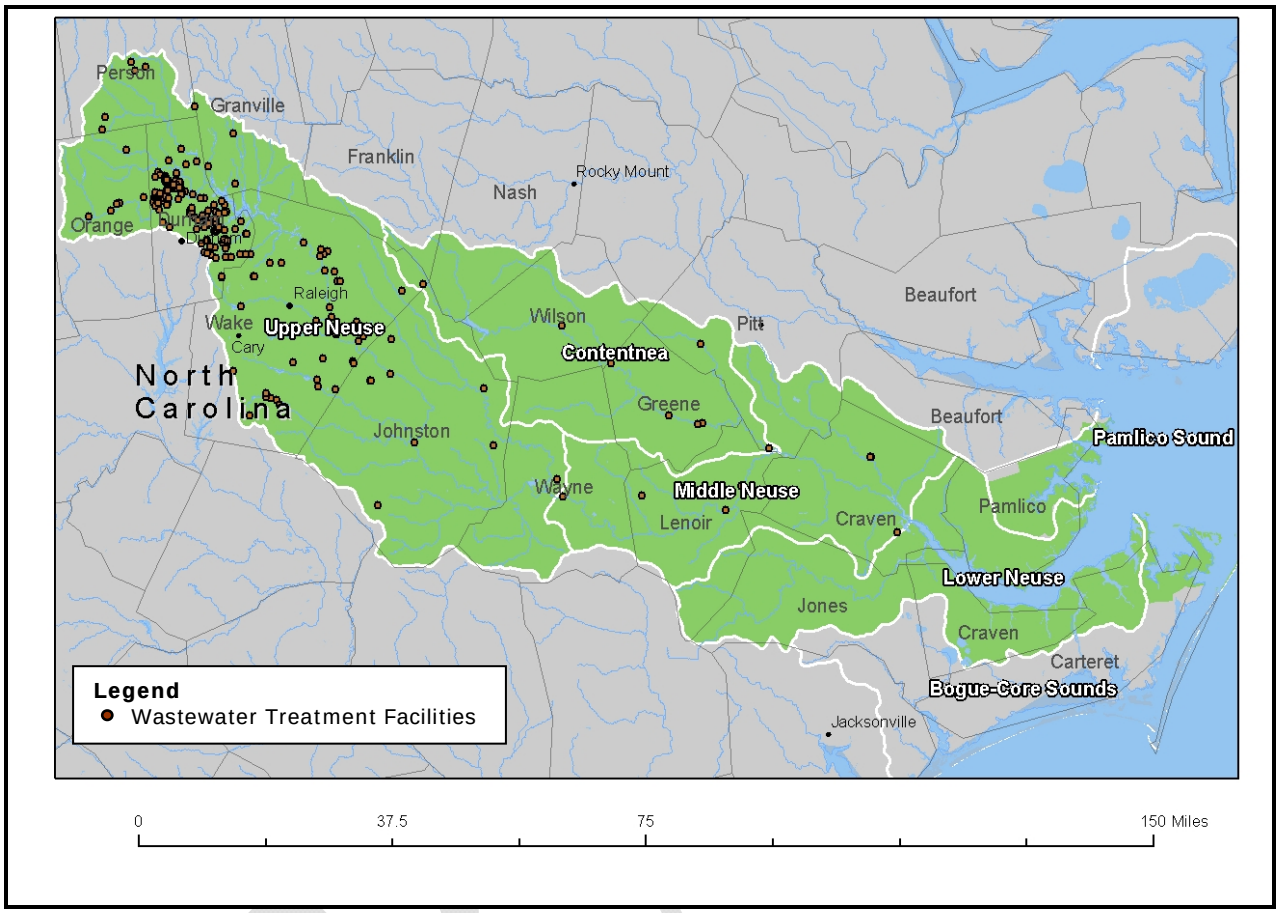
Several counties of the Neuse River watershed have some of the highest population growth rates in the state, with three of the 18 counties having a predicted growth of more than 30 percent by the year 2020. In 2006, the total watershed population was at 1.5 million* with an average projected growth rate of 28 percent to a population of almost two million by 2020.**[131] Some of the most populated areas of the watershed are located around the cities of Durham, Raleigh, Hillsborough, Cary, Apex, Goldsboro, Wilson, Kinston, and New Bern.[132]

The total water use in the Neuse River watershed is at nearly 200 million gallons per day, with residential demand accounting for more than 40 percent. Public water systems supplied 44 percent of the water used from surface water and 16 percent from groundwater. Privately supplied water systems accounted for another 40 percent of the water supply.[133] While groundwater is the primary source of water supply in the coastal regions of the watershed, the Upper Neuse region of the watershed relies heavily on surface water from lakes and rivers for supplies, accounting for almost two thirds of the total watershed water demand.[134]

According to EPA's datasystems, there are 295 wastewater treatment facilities with NPDES permits in the Neuse River watershed with more than 60 percent located in Durham County of the Upper Neuse sub-watershed (Figure 6-3). Twenty wastewater treatment facilities in the Neuse River watershed have 'major' NPDES* designations (Table 6-7).

* 2006 County populations obtained from the U.S. Census Bureau 2006 annual estimates across counties. Watershed population derived from the county population and percent of county in watershed, with the simplified assumption of uniform distribution of population across counties. For county level population data see Appendix B, Table B-3.
** Population estimates for 2020 obtained from the NCDENR DWQ, 2008 Neuse River Basin Water Quality Plan Draft.
* Each NPDES permit holder is defined by the program office as a Major or Minor discharger. Classification as a major discharger generally involves factors relating to the significance of the discharger's impact on the environment, such as nature and quantity of pollutants discharged, character and assimilative capacity of the receiving waters, presence of toxic pollutants in the discharge, and discharger's compliance history.

Figure 6-3: Wastewater Treatment Facilities in the Neuse River Watershed



Source: Data obtained from EPA's IDEA system on July 8, 2008. Query criteria include the following federal permits and identifiers: the NPDES permits, Clean Air Act air permits, Resource Conservation and Recovery Act hazardous waste IDs, and Toxic Release Inventory reporters between 2004 and 2006.

Table 6-7: Municipal Wastewater Treatment Facilities in the Neuse River Watershed

Sub-Watersheds	Number of Facilities	Number of NPDES Water Major Water Permits
Upper Neuse	274	12
Middle Neuse	7	2
Contentnea	8	4
Lower Neuse	6	2

Source: Data obtained from EPA's IDEA system on July 8, 2008. Query criteria include the following federal permits and identifiers: NPDES permits, Clean Air Act air permits, Resource Conservation and Recovery Act hazardous waste IDs, and Toxic Release Inventory reporters between 2004 and 2006.

Impairments and Concerns[†]

For several decades, the Neuse River watershed has been considered one of the most polluted watersheds in the country. It was designated as one of North America's most threatened Rivers by the American Rivers Organization in 1995, 1996, 1997, and 2007. Some point sources of pollution have been identified as municipal wastewater treatment facilities, industrial facilities, package treatment plants, and large urban and industrial stormwater systems. Nonpoint sources of pollution include construction, roads, failing septic systems and straight pipes, timber harvesting, hydrologic modifications, and agriculture.[135]

The American Rivers Organization has named swine pollution to be one of the leading causes of the river's pollution problems.[136] In the Lower Neuse sub-watershed, up to 60 percent of nitrogen and phosphorus overload can be attributed to fertilizer and animal waste.

In conjunction with the NCDENR, USGS performed a study in 2002 to evaluate nutrient transport at a concentrated animal feeding operation and assessed implications for nutrient loading in the Neuse River watershed. The study stated that in 2000, total nitrogen load delivered to the Neuse estuary was 4,807 tons and total phosphorus load was 425 tons. It was estimated that nearly half of the total nitrogen and phosphorus loads came from anthropogenic nonpoint sources. Nitrogen concentrations in the groundwater near or under areas treated with liquid swine waste were found to be significantly higher than in areas treated with synthetic fertilizers. According to a USGS testimony given to the Committee on Environment and Public Works, after four years of application, nitrogen concentrations from swine waste increased by 3.5 times in shallow ground water compared to concentrations prior to application. Also, median nitrogen concentrations were almost double from swine spray applications compared to commercial fertilizer.[137]

The 2006 North Carolina Clean Water Act Section 303(d) Threatened and Impaired Waters List, which lists waterbodies that are impaired or are threatened to be impaired by pollutants, has 41 waters listed for the sub-watersheds making up the Neuse River watershed (Table 6-8). The Upper Neuse has the most waters listed at 28. Overall, the most prevalent identified sources of impairment in the Neuse River watershed include biological integrity, low dissolved oxygen, and aquatic weeds.[138]

According to the 2008 draft of North Carolina's 303(d) list, Swift Creek and Williams Creek will be targeted for a high priority Total Maximum Daily Load[‡] (TMDL) development in the next two years for biological integrity. Falls Lake will be targeted for nutrients and turbidity.[139]

[†] The impairments cited here represent the monitoring activities taking place in the watershed and may not reflect the complete condition of the watershed.
[‡] A Total Maximum Daily Load (TMDL) is a regulatory term in the U.S. Clean Water Act, describing a value of the maximum amount of a pollutant that a body of water can receive while still meeting water quality standards.

Table 6-8: Neuse River Watershed 303(d) Threatened and Impaired Waters List (2006)

Sub-Watershed (# of Waters Listed)	Water Body Name (Number of water segments listed)	Cause of Impairment	TMDL Pollutant / Year of Est.
Upper Neuse (28)	Big Lake	Aquatic Weeds	Aquatic Weeds/ 2006
	Black Creek	Biological Integrity	
	Buffalo Creek	Biological Integrity	
	Buffalo Creek (Wendell Lake)	Biological Integrity	
	Crabtree Creek (3)	Biological Integrity	
		Turbidity	
	Ellerbe Creek (2)	Biological Integrity	
	Hare Snipe Creek	Biological Integrity	
	Knap Of Reeds Creek (2)	Biological Integrity	
	Lick Creek	Biological Integrity	
	Little Creek	Biological Integrity	
	Little Lick Creek (2)	Biological Integrity	
		Low Dissolved Oxygen	
	Marsh Creek	Biological Integrity	
	Mine Creek (2)	Biological Integrity	
	Perry Creek	Biological Integrity	
	Perry Creek (Greshams Lake)	Biological Integrity	
	Pigeon House Branch	Low Dissolved Oxygen	Fecal Coliform / 2003
			Copper / 2003
	Reedy Creek Lake	Aquatic Weeds	Aquatic Weeds/ 2006
	Swift Creek (2)	Biological Integrity	
	Walnut Creek (2)	Biological Integrity	
		Biological Integrity	
	Williams Creek	Biological Integrity	
Middle Neuse (7)	Clayroot Swamp	Biological Integrity	Aquatic Weeds/ 2006
	Core Creek	Biological Integrity	
	Creeping Swamp (3)	pH	
		Chlorophyll *a*	
		Dissolved Oxygen	
	Stony Creek	Biological Integrity	
	Swift Creek (3)	Biological Integrity	
		Biological Integrity	
		Biological Integrity	
Contentnea (4)	Contentnea Creek (Buckhorn Res.)	Biological Integrity	
	Little Contentnea Creek	Low Dissolved Oxygen	
	Little Creek (West Side)	Biological Integrity	
	Nahunta Swamp	Biological Integrity	
Lower Neuse (2)	Beaver Creek	Biological Integrity	
	Brice Creek	Biological Integrity	

Source: EPA Assessment TMDL Tracking and Implementation System (ATTAINS) database for 2006. Data obtained from <http://iaspub.epa.gov/waters10/attains_index.control?p_area=NC>

The North Carolina 2006 Clean Water Act Section 305(b) National Water Quality Inventory Report, which discloses conditions of all assessed waterbodies in the state including causes of impairment from types of pollution and likely sources of pollution, has eight waterbodies in the Neuse River Watershed listed as "impaired." Most often the impairment is attributed to pathogens and metals (Table 6-9).

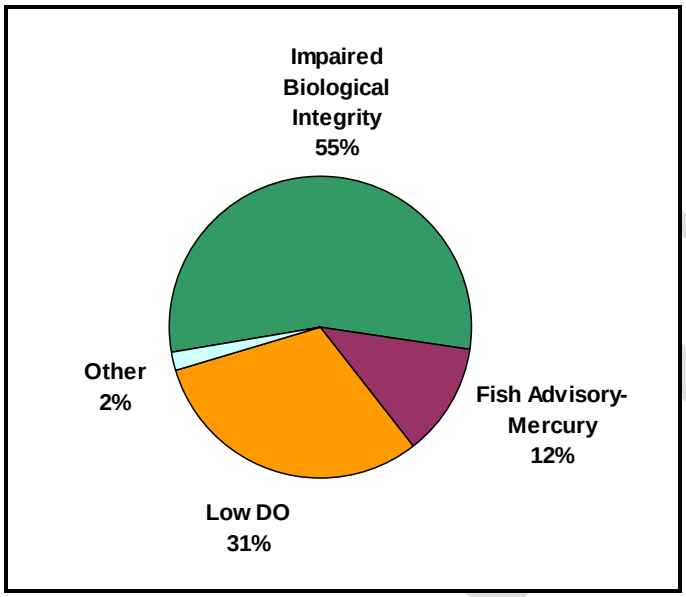
Table 6-9: Neuse River Watershed 305(b) List of Impaired Waters (2006)

Location	Water Type	Size	State Impairment	EPA Impairment Classification
From City of Goldsboro water supply intake to subbasin 030405-030412 boundary	River	5.8 miles	Mercury in fish tissue	Metals
DEH prohibited area at mouth of Clubfoot Creek	Wetlands, Tidal	96.2 acres	Fecal coliform	Pathogens
DEH prohibited area at mouth of Green Creek	Wetlands, Tidal	61.7 acres	Fecal coliform	Pathogens
DEH prohibited area at mouth of Peirce Creek	Wetlands, Tidal	7.7 acres	Fecal coliform	Pathogens
From Streets Ferry to subbasin 030408-030410 boundary	Wetlands, Tidal	426.5 acres	-	-
From subbasin 030408-030410 boundary to a line across Neuse River from Johnson Point to McCotter Point	Wetlands, Tidal	5,838 acres	-	-
From subbasin 030405-030412 boundary to mouth of Contentnea Creek	River	63.2 miles	Mercury in fish tissue	Metals
From a line across Neuse River from Johnson Point to McCotter Point to a line across Neuse River from Wilkinson Point to Cherry Point	Wetlands, Tidal	24,493 acres	-	-

Source: EPA ATTAINS database for 2006. <http://iaspub.epa.gov/waters10/attains_index.control?p_area=NC> Accessed on July 21, 2008.

In 2002, North Carolina prepared its first Integrated Report, also referred to as the Water Quality Assessment and Impaired Waters List. An Integrated Report integrates reporting requirements under the Clean Water Act sections 303(d) and 305(b) into a single water quality assessment document. According to the 2006 North Carolina Integrated Report, of the total waterbodies assessed within the Neuse River watershed, more than 15 percent of the freshwater streams and shorelines are considered to be impaired for reasons mainly of impaired biological integrity, low dissolved oxygen, and mercury. Other impairment causes include fecal coliform, turbidity, and copper (Figure 6-4).[140]

Figure 6-4: Reasons for Impairment of Freshwater Streams and Shorelines of the Neuse River Watershed



Source: North Carolina Water Quality Assessment and Impaired Waters List (2006 Integrated 305(b) and 303(d) Report).

Ninety-one acres of freshwater lakes, reservoirs, and impounded areas were found to be impaired by aquatic weeds and have at least one designated use impaired, though no TMDL was required at the time. Nearly 9 percent, or 31,767 acres, of estuarine and saltwater bays, inlets, and tidal areas of the watershed were impaired by chlorophyll, and 3,711 acres were impaired by fecal coliform (Table 6-10).[141]

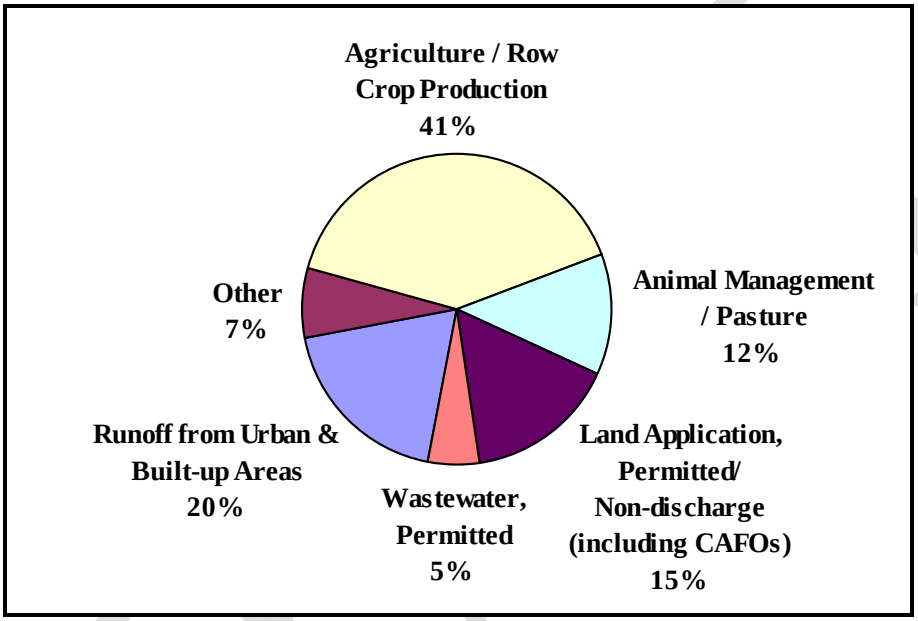
Table 6-10: Overall Assessment and Reasons for Impairment of Waterbodies in the Neuse River Watershed

	Freshwater Streams and Shorelines (miles)	Freshwater Lakes, Reservoirs, and Impounded Areas (acres)	Estuarine and Saltwater Streams and Shorelines (miles)	Estuarine and Saltwater Bays, Inlets, and Tidal Areas (acres)
Overall Assessment Information				
Total Assessed	3,373	16,414	124	369,967
At least 1 Use Impaired (No TMDL needed)	77	-	-	31,767
At Least 1 Use Impaired (TMDL Needed)	181	91	3	2,074
Aquatic Life Use Impaired; Biological Integrity	264	-	8	-
Shellfish use Impaired; Unfavorable for a TMDL	-	-	1	1,637
Reason for Impairment				
Impaired Biological Integrity	317	-	-	-
Fish advisory- Mercury	69	-	-	-
Low Dissolved Oxygen	177	-	-	-
Fecal Coliform	3	-	-	3,711
Chlorophyll	-	-	-	31,767
Turbidity	5	-	-	-
Copper	3	-	-	-
Aquatic Weeds	-	91	-	-

Sources: North Carolina Water Quality Assessment and Impaired Waters List (2006 Integrated 305(b) and 303(d) Report).

According to the 2006 Integrated Report, more than 70 percent of the watersheds' impairments are caused by agricultural activities such as row crop agriculture, animal management, and concentrated animal feeding operations. Other sources of impairments include runoff from urban areas, wastewater treatment facilities, and construction (Figure 6-5).[142]

Figure 6-5: Primary Sources of Impairment for Freshwater Streams and Shorelines of the Neuse River Watershed



Source: North Carolina Water Quality Assessment and Impaired Waters List (2006 Integrated 305(b) and 303(d) Report).

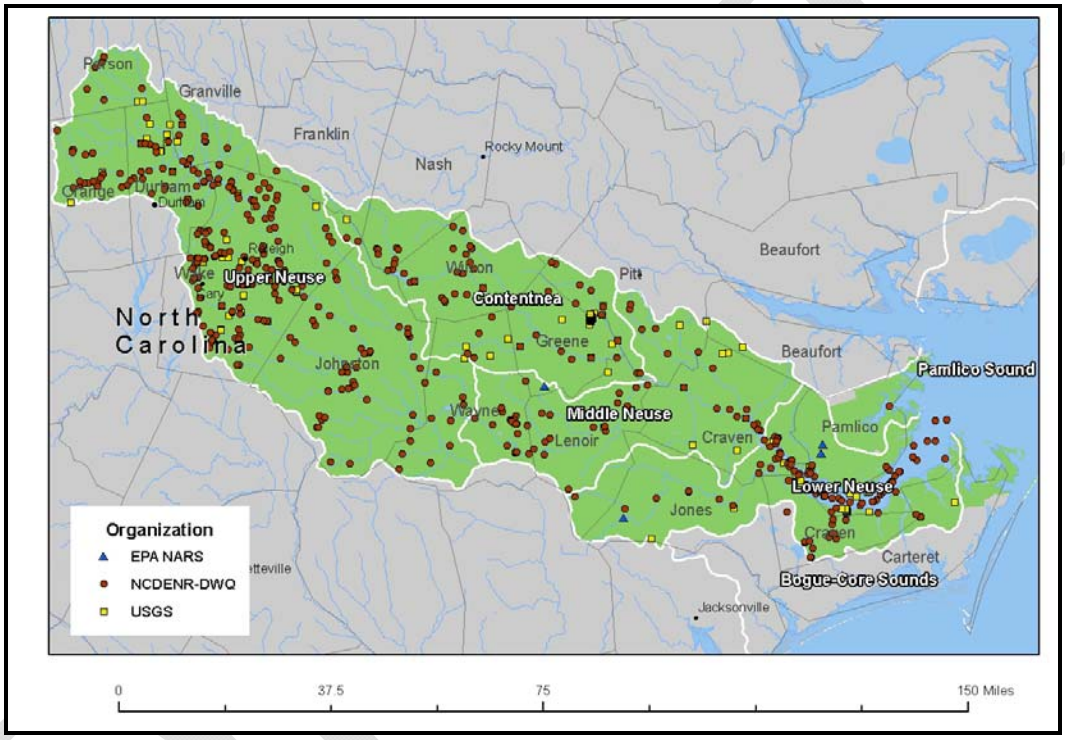
Water Quality Monitoring Stations

There are a number of organizations that routinely monitor water quality in the counties of the Neuse River watershed. While various organizations focus their monitoring efforts on particular pollutants, most report to EPA's Storage and Retrieval Data Warehouse (STORET). STORET is a data management system containing water quality information for the nation's waters. Organizations operating in the Neuse River watershed that report water quality data to the STORET database are the NCDENR DWQ, the National Aquatic Resource Survey (NARS), and the NCDENR DWQ-Shellfish Sanitation Recreational Water Quality Program (RWQP). The USGS National Water Information System stores water quality data of more than 1.5 million sites throughout the country and conducts monitoring for the entire spectrum of impairments as well as quantity, distribution, and movement of water parameters. The USGS has the most stations in the area, with over 200 operating in the Neuse River sub-watersheds (Table 6-11, Figure 6-6).

Table 6-11: Water Quality Monitoring Stations in the Neuse River Watershed				
Sub-Watershed	**Monitoring Organization**			
	USGS	**NCDENR-DWQ**	**NARS**	**NCDENR-RWQP**
Upper Neuse	68	573	0	0
Middle Neuse	10	107	12	0
Contentnea	71	120	0	0
Lower Neuse	57	164	3	1

Source: USGS National Water Information System. EPA's STORET.
Note: Monitoring stations active between 2002 to present, with at least one type of water quality parameter tested at the site.

Figure 6-6: Water Quality Monitoring Stations in the Neuse River Watershed



Source: USGS National Water Information System. EPA's STORET.

Studies and Initiatives

Fish kills in the Neuse River watershed in 1995 and the subsequent findings of pfiesteria, led to the North Carolina Environmental Management Commission to adopt what is commonly referred to as Neuse Rules, or the Neuse River Nutrient Sensitive Waters Management Strategy. The rules adopted include the Riparian Buffer Rule, the Point Source Wastewater Discharge Rule, the Stormwater Rule, the Nutrient Management Rule, and the Agricultural Rule. The high levels of chlorophyll *a* in the estuary were determined to be caused by excessive nitrogen loading; therefore, a 30 percent nitrogen reduction goal was adopted for the five years between 1998 and 2003. The Agricultural Rule also included a mandatory combination of the following best management practices (BMPs) to be adopted:

- 50 ft. riparian buffer or

- Nutrient management plan (meeting U.S. Department of Agriculture standards) and 20 ft forested riparian buffer or
- Nutrient management plan (meeting U.S. Department of Agriculture standards) and controlled drainage or
- Local area option (use nitrogen accounting tool)

To be able to accurately monitor nutrient losses, changes, and BMP implementation rates, the North Carolina Nutrient Assessment Tool was developed, which contains two field-scale assessment tools, the Nitrogen Loss Estimation Worksheet, and the Phosphorus Loss Assessment Tool.

According to the 2006 Progress Report on the Neuse Agricultural Rule, more than a quarter of nitrogen loss reductions were attributed to improvements in fertilizer management and cropland attenuation (Table 6-12).[143]

Table 6-12: Nitrogen Reductions on Agricultural Lands from the 1991-1995 Baseline Levels in the Neuse River Watershed in 2006 (estimated via Nitrogen Loss Estimation Worksheet)

Activity	Percent Reduction in Nitrogen
BMP Implementation	8%
Fertilizer Management	16%
Cropping Shift	5%
Cropland Converted to grass/tree	1%
Cropland lost to idle land	10%
Cropland lost to development	5%
Total	45%

Source: Annual Progress Report in the Neuse Agricultural Rule. A Report to the NC Environmental Management Commissions from the Neuse Basin Oversight Committee. Crop year 2006.

Implementation goals were set up for nitrogen-reducing BMPs by the local nitrogen reduction committee and approved by the Environmental Management Commission in 1999. From the original goals set in 1999, implementation of agricultural BMPs has exceeded all of the original goals with the exception of nutrient management (Table 6-13).[144] Other BMPs that provide water quality benefits other than nitrogen reduction, such as sediment and phosphorus reductions, have also made substantial impacts on surface water and shallow ground water quality (Table 6-14).

Table 6-13: Agricultural BMPs Resulting in Nitrogen Reduction in the Neuse River Watershed

BMP Types	BMP Installation Goals	Goal Exceedance as of 2006
20' Buffer	1,370	68,647
30' Buffer	700	9,742
50' Buffer	2,000	28,613
70' Buffer	0	11,483
100' Buffer	0	109,655
Scavenger Crop	5,200	26,009
Nutrient Management	280,000	-12,131

Source: Annual Progress Report in the Neuse Agricultural Rule. A Report to the NC Environmental Management Commissions from the Neuse Basin Oversight Committee. Crop year 2006.

Table 6-14: Foot Print Area of Agricultural BMPs that Provide Water Quality Benefits In Addition to Nitrogen Reduction in the Neuse River Watershed (1996 – 2006)

BMP Types	Acres
Conservation Tillage	77,719
Conservation Tillage-3 years	8,608
Critical Area Planting	28
Diversions	130,901
Field Border	610
Grassed Waterway	2,138
Land Smoothing	129
Livestock Exclusion	64,298
Long term no-till	14,508
Sod Based Rotation	4,085
Streambank Stabilization	350
Strip Cropping	165
Terraces	13,657

Source: Annual Progress Report in the Neuse Agricultural Rule. A Report to the NC Environmental Management Commissions from the Neuse Basin Oversight Committee. Crop year 2006. Note: Foot print area refers to area of impact rather than area of direct implementation.

Reduction in fertilizer application rates is another important conservation effort in the watershed. Since the 1991-1995 baseline, the reduction of average rate of fertilizer application on major crops has dropped between 4% (for wheat) and 96% (for soybeans), with the large variability reflecting the differing nutrition needs of the various crops (Table 6-15).[145]

Table 6-15: Percent Reduction from the 1991-1995 Baseline of Average Fertilization Rate for Major Crops in the Neuse River Watershed

Crop	% Reduction from Baseline (lbs/acre)
Corn for Grain	18
Cotton	12
Soybeans	96
Tobacco	14
Wheat	4

Source**:** Annual Progress Report in the Neuse Agricultural Rule. A Report to the NC Environmental Management Commissions from the Neuse Basin Oversight Committee. Crop year 2006.

According to the 2008 Neuse River Basin Water Quality Plan Draft, the 30 percent nitrogen reduction goal set by point source dischargers and agriculture has been met and exceeded; however, the overall goal of a 30 percent nitrogen reduction in the Neuse Estuary from all other sources is yet to be achieved. Some major sources that continue to contribute excess amounts of nitrogen to the watershed are runoff from stormwater and concentrated animal feeding operations, the latter of which may also be a leading cause in the increase of nitrogen load in the estuary due to ammonia volatilization and subsequent atmospheric deposition.[146]

Table 6-16 summarizes other local, regional, state, and federal programs and coalitions striving to conserve and improve the water resources of the region.

Table 6-16: Initiatives and Studies

Organization	Initiative/ Study Name	Description / Findings

USGS	National Water Quality Assessment Program / Albemarle-Pamlico Study Unit 1991-2001[147]	▪ The Neuse River watershed is one of four major river basins included in the study unit.
		▪ The nearly 18 million acre study unit was analyzed for water chemistry, hydrology, stream habitat, and aquatic life.
		▪ Surface Water Investigations
		  ▪ A major concern is the excessive amounts of nutrients present in the surface waters.
		  ▪ The Neuse River basin had some of the highest nitrogen concentrations (1 to 3 mg/L) out of the four basins assessed.
		  ▪ The Neuse River and Contentnea Creek had the highest yields of nutrients and contributed the largest percentage of nitrogen and phosphorus to the sounds.
		  ▪ Though the Neuse River watershed makes up only 20% of the total drainage area of the Albemarle-Pamlico drainage basin, it accounts for almost half of the phosphorus entering the sounds.
		  ▪ Some of the major contributors of nutrients to the basins were determined to be agricultural fertilizer and livestock waste.
		▪ Groundwater Investigations
		  ▪ Groundwater quality was evaluated using statistically based land-use, study-unit surveys, and flow-path studies. Three synoptic studies also were conducted to investigate the relation between ground-water quality and surface-water quality.
		  ▪ Studies focused on the effects of corn and soybean agriculture and urban activities on shallow ground-water quality.
		  ▪ Water samples were analyzed for physical properties, major ions, nutrients, pesticides, and volatile organic compounds and radiochemicals such as radium and uranium isotopes and radon.
		  ▪ Samples indicated high phosphorus concentrations in the Coastal Plains of the Neuse Basin, with several stations indicating that phosphorus concentrations are higher in discharging ground water than in surface water, thus indicating the possibility that geologic origin contributes significantly to the in-stream phosphorus load.
		▪ Pesticides such as metolachlor, atrazine, prometon, alachlor, and DDT as well as herbicides and insecticides were detected in most surface water samples and in many groundwater samples.

	National Water Quality Assessment Program / Albemarle-Pamlico Study Unit 2001-2011[148]	▪ A SPARROW model was developed that uses basin and nutrient source characteristics, routing, and nutrient processing to predict nitrogen and phosphorus loads in the Tar, Neuse, and Cape Fear Rivers. The model will be recalibrated and expanded to include recent data in the Roanoke River and additional sites in the Tar, Neuse, and Cape Fear Rivers. ▪ A series of 15 wells along a flow path located in the Little Contentnea Creek basin will be resampled for nutrients. The water will be age-dated and a contaminant transport model will be developed. ▪ Four principal sites in the surface-water trend network are regularly sampled to evaluate seasonal and long-term trends and to characterize the types of chemicals found in the basins. The sites include the Van Swamp at Hoke, the Neuse River at Kinston, Contentnea Creek at Hookertonand, and Swift Creek in near Apex.

Table 6-16: Initiatives and Studies

Organization	Initiative/ Study Name	Description / Findings
Upper Neuse River Basin Association[149]	Multiple Watershed Planning and Restoration Projects	▪ The mission of the Association is to preserve the water quality of the Upper Neuse River Basin through innovative and cost-effective pollution reduction strategies, and to constitute a forum to cooperate on water supply issues within the Upper Neuse River Basin by: ▪ Forming a coalition of units of local government, public and private agencies, and other interested and affected communities, organizations, businesses, and individuals to secure and pool financial resources and expertise; ▪ Collecting and analyzing information and data and developing, evaluating, and implementing strategies to reduce, control, and manage pollutant discharge; and ▪ Providing accurate technical, management, regulatory, and legal recommendations regarding the implementation of strategies and appropriate effluent limitations on discharges into the Upper Neuse River Basin.
NCDENR Division of Soil and Water Conservation	North Carolina Agriculture Cost Share Program[150]	▪ Voluntary program, established in 1984, to help reduce agricultural non-point runoff into state waters. ▪ Helps farmers improve on-farm management by implementing BMPs and reimbursing farmers up to 75% of the cost ▪ Approved BMPs can be divided into the following five categories: ▪ Sediment/Nutrient Delivery Reduction from Fields ▪ Erosion and Nutrient Loss Reduction in Fields ▪ Stream Protection from Animals ▪ Proper Animal Waste Management ▪ Agricultural Chemical Pollution Prevention
North Carolina Department of Transportation, NCDENR, and the U.S. Army Corps of Engineers	North Carolina Ecosystem Enhancement Program[151]	▪ The mission of the Program is to "restore, enhance, preserve, and protect the functions associated with wetlands, streams, and riparian areas, including but not limited to those necessary for the restoration, maintenance, and protection of water quality and riparian habitats throughout North Carolina." ▪ The program provides: ▪ High-quality, cost-effective projects for watershed improvement and protection; ▪ Compensation for unavoidable environmental impacts associated with transportation-infrastructure and economic development; and ▪ Detailed watershed-planning and project-implementation efforts within North Carolina's threatened or degraded watersheds.
NCDENR and University of North Carolina	Neuse River Estuary Modeling and Monitoring Project[152]	▪ Performs space and time sensitive monitoring and assessment of water quality and environmental conditions, including nutrient-eutrophication dynamics, algal blooms, hypoxia, fish kills. ▪ The project is the main source of data calibration, verification, and validation of water quality models used to develop and test TMDLs for the Neuse River Estuary. ▪ The project also serves state and federal agencies such as EPA, the National Oceanic and Atmospheric Administration, and the National Aeronautics and Space Administration.

Table 6-16: Initiatives and Studies

Organization	Initiative/ Study Name	Description / Findings
Lower Neuse Basin Association[153]	Participant of the North Carolina NPDES Discharge Monitoring Coalition Program[154]	▪ Formed in 1994 by municipalities and industries located in the Lower Neuse Basin. ▪ The Association's mission is to preserve the waters of the Lower Neuse River through innovative and cost-effective wastewater treatment and reduction strategies. ▪ The NPDES Discharge Monitoring Coalition Program was developed by NCDENR DWQ to use NPDES instream monitoring requirements to assess water quality within a watershed context. ▪ Participating permit holders voluntarily develop monitoring programs designed to evaluate coalition interests and watershed specific issues. ▪ The Association initiated monitoring in 1994 and has 23 participating permit holders with 48 active monitoring stations.
NCDENR DWQ	Neuse River Basin Model[155]	▪ Hydrologic model development project for Neuse River basin. Project initiated on February 25, 2008. ▪ Model will be used for surface water management purposes, in particular to evaluate potential impacts of proposed projects with significant water withdrawals within the basin and inter-basin transfer permit application, planning for increased water use due to continuous growth, and real time management of basin's resources, and operational and regulatory constraints during a drought condition. ▪ Model will be structured as a mass balance, water resource simulation, and optimization tool with expert geographical resolution and timestep.

Center for Agricultural Partnerships	North Carolina Neuse Crop Management Project[156]	▪ The project established a partnership among farmers, crop consultants, agribusinesses, grower organizations, and NC State University research and extension to reduce unnecessary nitrogen and herbicide use and losses, thereby protecting water resources in the Neuse River Basin. Specific accomplishments include:
		  ▪ More than 105,000 acres of nutrient management plans written and implemented;
		  ▪ A 23% reduction in the amount of fertilizer nitrogen applied per acre of cropland; and
		  ▪ A greater than 40% reduction in soil-applied preemergence herbicides.

APPENDIX B

Table B-1: Counties of the Neuse River Sub-Watersheds

Upper Neuse	Middle Neuse	Contentnea	Lower Neuse	Pamlico Sound	Bogue-Core Sounds
Wake	Craven	Franklin	Carteret	Carteret	Carteret
Franklin	Greene	Greene	Craven	Pamlico	Pamlico
Johnston	Jones	Johnston	Pamlico		
Wayne	Wayne	Lenoir	Jones		
Wilson	Lenoir	Nash	Lenoir		
Durham	Pitt	Pitt			
Granville	Beaufort	Wake			
Orange		Wayne			
Person		Wilson			

Table B-2: NCDENR Delineated Subbasins of the Neuse River Sub-Watersheds

Upper Neuse	Middle Neuse	Contentnea	Lower Neuse	Pamlico Sound	Bogue-Core Sounds
03-04-01	03-04-05	03-04-07	03-04-10	03-04-13	03-04-14
03-04-02	03-04-08		03-04-11		
03-04-03	03-04-09				
03-04-04					
03-04-06					
03-04-12					

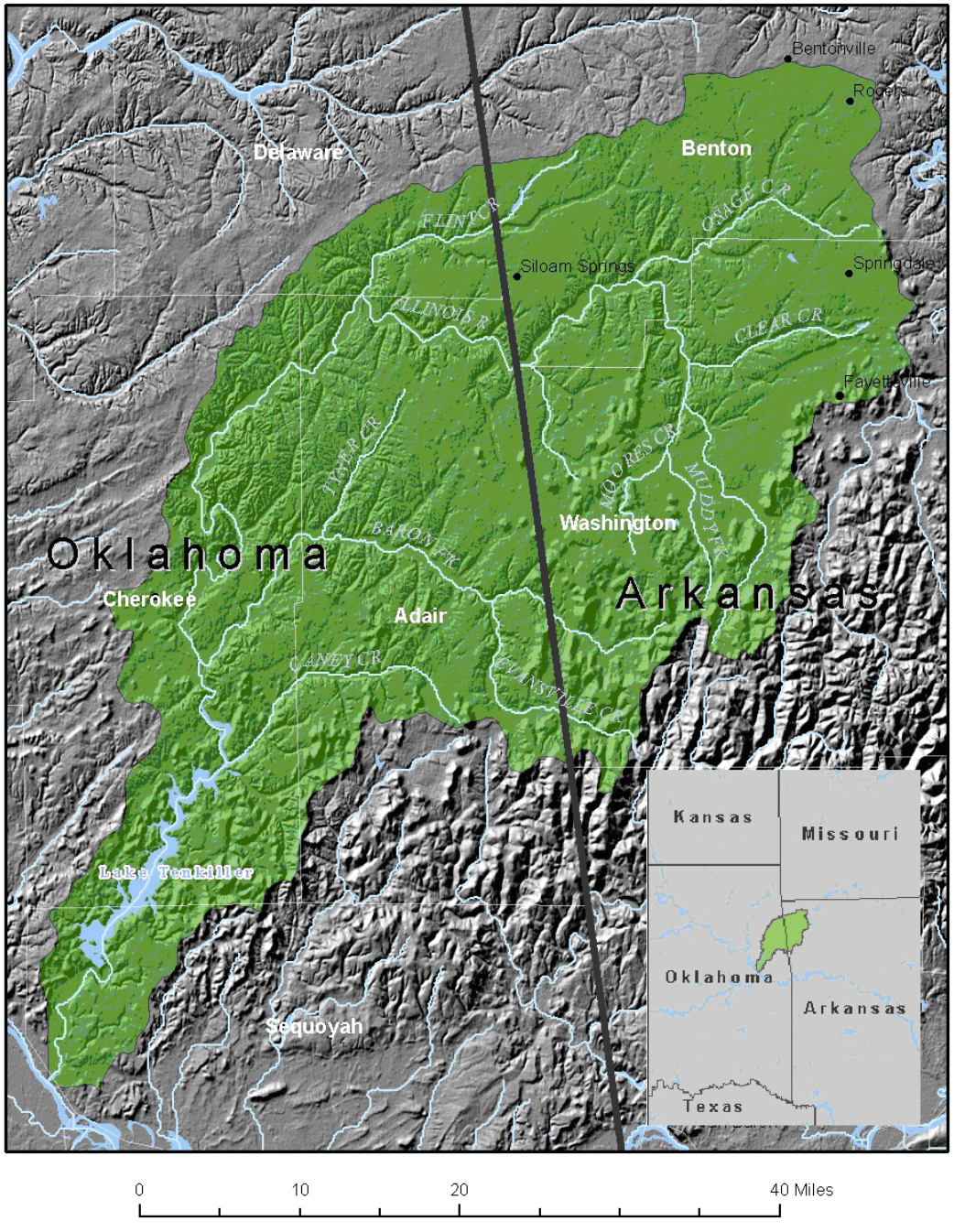
Table B-3: Neuse River Watershed Population and Projected Growth

County	% County in the Basin*	County Population in 2006†	Basin Population in 2006‡	Estimated Population for 2020§	Estimated Basin Population for 2020	Estimated % Growth 2006 - 2020
Beaufort	2	46,355	927	49,046	981	6
Carteret	50	63,584	31,792	69,000	34,500	9
Craven	95	94,875	90,131	96,449	91,627	2
Durham	73	246,896	180,234	297,461	217,147	20
Franklin	10	55,886	5,589	73,037	7,304	31
Granville	25	54,473	13,618	69,054	17,264	27
Greene	100	20,157	20,157	24,892	24,892	23
Johnston	98	152,143	149,100	217,764	213,409	43
Jones	81	10,204	8,265	10,499	8,504	3
Lenoir	99	57,662	57,085	57,437	56,863	-0.39
Nash	20	92,312	18,462	104,871	20,974	14
Orange	49	120,100	58,849	149,080	73,049	24
Pamlico	83	12,785	10,612	14,136	11,733	11
Person	32	37,341	11,949	43,901	14,048	18
Pitt	42	145,619	61,160	172,440	72,425	18

* Source: North Carolina Center for Geographic Information and Analysis
† 2006 County populations derived from the U.S. Census Bureau 2006 annual estimations.
‡ Basin population calculated with the simplified assumption of uniform distribution of county populations.
§ Population estimates for 2020 derived from the NCDENR DWQ. 2008 Neuse River Basin Water Quality Plan Draft.

Table B-3: Neuse River Watershed Population and Projected Growth						
County	**% County in the Basin***	**County Population in 2006†**	**Basin Population in 2006‡**	**Estimated Population for 2020§**	**Estimated Basin Population for 2020**	**Estimated % Growth 2006 - 2020**
Wake	85	786,522	668,544	1,106,218	940,285	41
Wayne	91	113,847	103,601	125,614	114,309	10
Wilson	81	76,624	62,065	86,916	70,402	13
Total Basin			**1,552,141**		**1,989,714**	**28**

Illinois River Watershed



Illinois River Watershed Summary	
Area	• 1,069,530 acres (54% in Oklahoma and 46% in Arkansas)
Location	• 7 Counties in 2 States: Benton, Crawford, and Washington in Arkansas; Adair, Cherokee, Delaware, Muskogee, and Sequoyah in Oklahoma
Population	• As of 2000 - 20,623 in Oklahoma and 174,691 in Arkansas
Land Use	• Arkansas: 53% of the Arkansas portion of the watershed is pasture, 37% is forest, and 10% is urban • Oklahoma: 54% of the Oklahoman counties in the watershed are farm land
Agriculture	• Arkansas is the second largest producer of broilers in the United States; Benton County is the largest contributor in the state (2007) • The majority of the land used for crops in the counties that make up the watershed is dedicated to forage - 333,204 acres in 2002
Food Manufacturing	• 25 federally-regulated food processing facilities identified in EPA data systems • Most common industries include Poultry Slaughtering and Processing, and Prepared Feeds and Feed Ingredients for Animals and Fowls • Northwest Arkansas is home to the headquarters of Wal-Mart, the world's largest public corporation by revenue, and Tyson Foods, the largest meat producer in the world
Municipalities	• Northwest Arkansas is one of the fastest growing metropolitan areas in the United States • The Fayetteville Municipal Statistical Area grew 13.2 times faster than the state of Arkansas from 1990 and 2000 • 19 federally-regulated wastewater treatment facilities with 6 holding "major" designations under the National Pollutant Discharge Elimination System
Impairments and Concerns	• Key pollutants of concern are elevated nutrients (particularly phosphorus) • The Oklahoma Water Resources Board stated that the major source appears to be sewage treatment plant discharges and agricultural and urban/residential runoff • 6% of the waterbodies in Arkansas' portion of the watershed and 74% of the waterbodies in Oklahoma's portion of the watershed are listed as "impaired" (305(b))
Studies and Initiatives	• Oklahoma State University and the Oklahoma Conservation Commission performed and Analysis of Bank Erosion on the Illinois River in Northeast Oklahoma • The Illinois River Watershed Partnership planted riparian buffers along streambanks under the Riparian Project

Introduction

The Illinois River runs from the Northwest corner of Arkansas passing through the counties of Benton, Crawford, and Washington, into Northeast Oklahoma, passing through the counties of Adair, Cherokee, Delaware, Muskogee, and Sequoyah. Along its 99 mile course, the Illinois River runs through Lake Tenkiller, a 13,000 acre water reservoir with a 130 mile-long shoreline, before joining the Arkansas River at Gore, Oklahoma.

The Illinois River watershed encompasses 1,069,530 acres, with 576,030 acres in Oklahoma and 493,500 acres in Arkansas. The United States Geological Survey (USGS) classifies the Illinois River Watershed using the Hydrologic Unit Coding (HUC) system as 11110103. In addition to the Illinois River, the watershed contains a number of smaller tributaries, including Caney Creek, Evansville Creek, Flint Creek, Osage Creek, and the Baron Fork River.

The watershed plays an important economic role for both Arkansas and Oklahoma by virtue of its recreational attractions such as hunting, fishing, hiking, camping, and boating. An analysis undertaken in 2002 by the Oklahoma Water Resources Board (OWRB) states the Illinois River attracts over 500,000 visitors a year and contributes $9 million a year in economic benefit to the surrounding areas. Additionally, Lake Tenkiller provides economic benefits to the surrounding area that are not included in the $9 million figure.[157]

In 1977, Oklahoma enacted the Scenic Rivers Act, legislation declaring that certain Oklahoma rivers possessed "such unique natural scenic beauty, water conservation, fish, wildlife and outdoor recreational values of present and future benefit to the people of the state that it is the policy of the Legislature to preserve these areas."[158] Along with some of waters in the Illinois River watershed (portions of the Illinois, Flint Creek, and Baron Fork Creek), the Scenic Rivers Act also designated the Big Lee Creek, Little Lee Creek, and the Mountain Fork River as Scenic Rivers. The Act called for: identifying all water pollution sources; developing Total Maximum Daily Loads (TMDLs) for the amount of a pollutant that can be absorbed by a body of water before standards are breached; and preparing load reduction goals, compliance schedules, and other prevention measures.

Initial concerns about the watershed started in the mid-1980's when water quality in the lower portions of the Illinois River suffered from high levels of phosphorus, with the associated increased algal growth and reduced oxygen levels. A significant source of the increased phosphorus levels was the city of Fayetteville, Arkansas, which is the largest city in the Illinois River Watershed with a 2000 population of 58,047. Downstream Oklahoma sued Fayetteville to decrease the level of phosphorus being discharged into the river. In 1992, a Supreme Court ruling forced upstream discharging facilities to increase nutrient removal from their waste streams.[159] Furthermore, the Court ruled that the water quality of the Illinois River must meet Oklahoma standards at the state line.[160]

In 2002, OWRB's Beneficial Monitoring Program demonstrated that the water quality in the river was still not meeting the standards. The increased phosphorus levels were attributed to "sewage treatment plant discharges and agricultural and urban/residential runoff," originating mainly in the five municipalities in northwest Arkansas of Rogers, Springdale, Siloam Springs, Fayetteville, and Bentonville.[161,] As a result, the OWRB passed a

standard that capped the thirty day geometric mean of phosphorus at 0.037 milligrams per liter in all designated Scenic Rivers, giving all point source facilities ten years to come into compliance. The rule utilized a tiered approach that required larger municipal dischargers to cap their phosphorus discharges at 1 milligram per liter in the initial period, forcing these facilities to negotiate with smaller dischargers to achieve the target.

Agriculture

The U.S. Department of Agriculture indicated that, as of 2007, Arkansas was the second largest producer of broilers in the United States.[162] The 2002 Census of Agriculture indicated that Benton County was the focal point of this boom, possessing the largest inventory of broilers and other meat-type chickens of all counties in Arkansas.[163] Not surprisingly, in this region the majority of income being produced is through cattle, hogs, and poultry operations.[164] Also, as of 2004, the majority of the land in the Arkansas portion of the Illinois River watershed was used for pasture. Table 7-1 summarizes the land cover statistics for the Illinois River watershed in Arkansas.

Table 7-1: Summary Agricultural Statistics for the Illinois River Hydrologic Region in Arkansas (2004)

Total Area of Illinois River Hydrologic Region in Arkansas (sq. miles)	756
Pasture (sq. miles)	386
Pasture as Percent of HUC area in Arkansas	53%
Forest (sq. miles)	267
Forest as Percent of HUC area in Arkansas	37%
Urban (sq. miles)	70
Urban as a Percent of HUC area in Arkansas	10%
Water (sq. miles)	2.4
Water as Percent of HUC area in Arkansas	0.3%

Sources: Center for Advanced Spatial Technologies. 2006. Arkansas Watershed Information System. "8-digits – 11110103." Available at: http://watersheds.cast.uark.edu/viewhuc.php?hucid=11110103

The Oklahoma Conservation Commission (OCC) reports similar livestock production trends in their portion of the watershed, stating that "agriculture increased substantially in the basin (watershed) in the form of concentrated animal feeding operations, primarily poultry operations, and forest land continues to be cleared for pasture and hay production."[165] While Oklahoma does have a large poultry industry, its cattle industry is larger. As of 2007, Oklahoma had the fifth largest inventory of cattle and calves of all U.S. states.[166] However, the cattle industry in Oklahoma is not centered in the Illinois River watershed as Delaware county, the highest cattle producing county in the watershed, is ranked 43rd statewide. In 2002, 54 percent of the total land in the Oklahoman counties that encompass the Illinois River watershed was farmland. Table 7-2 provides summary statistics for the counties in Oklahoma that encompass the watershed.

Table 7-2: Summary Agricultural Statistics of Oklahoman Counties in the Illinois River Watershed (2002)	
Total Area of the Oklahoman Counties in the Illinois River Basin (acres)	1,781,536
Land in Farms (acres)	963,069
Land in Farms as a Percentage of Total County Area	54%
Total Cropland (acres)	410,058
Total Cropland as a Percentage of Land in Farms	43%
Harvest Cropland (acres)	201,473
Harvest Cropland as a Percentage of Total Cropland	49%
Cropland used only for Pasture or Grazing (acres)	192,559
Cropland used only for Pasture or Grazing as a Percentage of Total Cropland	47%

Sources: 2002 Census of Agriculture (U.S. Department of Agriculture). Oklahoma County Level Data.
Note: The Illinois River watershed encompasses portions of Adair, Cherokee, Delaware, Muskogee, and Sequoyah counties in Oklahoma. However, as stated earlier, Muskogee County information is intentionally omitted from the statistics describing the Illinois River watershed as it too encompasses only a negligible portion of the total area. Because the watershed boundaries differ from county boundaries, the data presented in the Table represent a larger area than the watershed.

Table 7-3 presents more detailed information on the crops harvested and the livestock raised in the counties that encompass the Illinois River watershed. Across the counties that encompass the watershed, the majority of the land used for harvesting crops is dedicated to forage. As of 2002, Benton County had the third largest inventory of broilers and other meat-type chickens, and generated the third highest total sales of poultry and eggs out of all counties in the United States.[167] Meanwhile Washington County possessed the ninth largest inventory of broilers and other meat-type chickens of all counties in the United States.[168]

Table 7-3: Harvested Crops and Livestock Inventory for Counties of the Illinois River Watershed (2002)

	Arkansas		Oklahoma				Total
	Benton	Washington	Adair	Cherokee	Delaware	Sequoyah	
Crops Harvested (acres)							
Barley for Grain	-	-	-	-	-	(D)	0
Corn for Grain	-	-	-	(D)	(D)	5,960	5,960
Corn for Silage	440	240	195	-	(D)	(D)	875
Cotton	-	-	-	-	-	-	0
Forage - land used for all hay and haylage, grass silage, and greenchop	75,641	84,393	38,312	38,450	59,484	36,924	333,204
Land in Orchards	187	490	49	458	184	17	1,385
Oats for Grain	-	-	-	-	-	-	0
Peanuts for nuts	-	-	-	-	-	-	0
Potatoes	(D)	1	5	-	-	-	6
Rice	-	-	-	-	-	(D)	0
Sorghum for Grain	(D)	-	-	-	642	288	930
Soybeans for beans	482	-	-	-	1,790	10,157	12,429
Sunflower Seed	-	-	-	-	-	-	0
Vegetables harvested for sale	1,078	167	252	(D)	457	(D)	1,954
Wheat for Grain	1,213	173	1,642	(D)	2,868	3,802	9,698
Livestock Inventory (number)							
Beef Cows	60,948	60,753	28,028	25,333	40,089	22,126	237,277
Broilers	128,066,609	109,890,530	12,942,745	3,594,006	37,154,935	1,025,105	292,673,930
Hogs and Pigs	(D)	56,051	406	463	(D)	611	57,531
Layers	1,221,497	2,921,380	517,615	(D)	791,272	94,735	5,546,499
Milk Cows	3,435	2,528	7,526	2,376	3,057	73	18,995
Sheep and Lamb	1,636	1,314	849	715	1,062	149	5,725

Source: 2002 Census of Agriculture (U.S. Department of Agriculture).
Note: (D) Signifies that data was withheld to avoid disclosing data for individual farms. "-"Represents zero.
Information on Crawford County and Muskogee County is intentionally omitted from the statistics describing the Illinois River watershed as they encompass only a negligible portion of the total area.

Given the size and growth of the livestock operations in Arkansas and Oklahoma and their potential impact on the water quality in the watershed, a survey was conducted by the OCC in 1997 to inventory the number of concentrated animal feeding operations. The survey showed that while the poultry inventory greatly outnumbered the beef cattle inventory, beef cattle were responsible for 41 percent of the phosphorus excreted into the watershed compared with 34 percent coming from chickens and 10 percent from turkeys. According to the Commission, this discrepancy arises not from the size difference, but because grazing cattle have access to waterbodies.[169]

Food Manufacturing

EPA's data systems showed 25 federally regulated food processing facilities in the Illinois River watershed, most of which are involved in livestock operations (poultry slaughtering and processing, and prepared food for animals and fowls). Table 7-4 presents summary statistics for the federally regulated food product facilities in the Illinois River watershed. Figure 7-1 plots the facilities on a map of the watershed.

Table 7-4: Federally Regulated Food Product Facilities in the Illinois River Watershed

SIC Code: Industry Description	Facility Name	City	State	NPDES Water Permit (Y/N)
2015: Poultry Slaughtering and Processing	Rogers Further Processing – Tyson Foods, Inc.	Rogers	AR	No
	Simmons Foods Incorporated Plant 1	Siloam Springs	AR	Yes
	Tyson Foods - Berry	Springdale	AR	Yes
	Georges Processing Plant	Springdale	AR	Yes
	Cargill Inc.	Springdale	AR	No
	Tyson Foods – Cornish Plant	Springdale	AR	No
	Tyson Foods – Lab Services - Rogers	Rogers	AR	No
	Siloam Springs Plant 1	Siloam Springs	AR	No
	Tyson Foods – Randall Wobbe Road	Springdale	AR	Yes
	Simmons Foods	Siloam Springs	AR	Yes
	Tyson – Research and Technology	Springdale	AR	No
2022 - Natural, Processed, and Imitation Cheese	Kraft Foods, Inc - Bentonville	Bentonville	AR	No
2033 - Canned Fruits, Vegetables, Preserves, Jams, and Jellies	Pappas Foods, LLC	Springdale	AR	Yes
2037 - Frozen Fruits, Fruit Juices, and Vegetables	Mrs. Smiths Bakery of Stilwell	Stilwell	OK	Yes
2048 - Prepared Feeds and Feed Ingredients for Animals and Fowls, Except Dogs and Cats	Tyson Foods Incorporated – Johnson Road Feedmill	Springdale	AR	No
	Cargill Turkey Productions, LLC	Springdale	AR	Yes
	Tyson Foods, Inc. – Westville Feedmill	Westville	OK	No
	Cargill Nutrena Feeds	Springdale	AR	Yes
	Georges Truck Stop	Springdale	AR	Yes
	Cobb-Vantress, Inc. Feed Mill	Siloam Springs	AR	No
	Tyson Foods – Johnson Road Feedmill	Springdale	AR	Yes
	Tyson Foods – Cobb Feedmill	Siloam Springs	AR	Yes
2051 - Bread and Other Baked Goods except Cookies	McKee Foods Corp	Gentry	AR	No
	Harris Baking Co.	Rogers	AR	Yes
2077 - Animal and Marine Fats and Oils	Simmons Industries	Siloam Springs	AR	No

Source: Data generated from EPA's Integrated Data for Enforcement Analysis (IDEA) system for Food and Kindred Products Manufacturing. Federal permits and identifiers considered include NPDES permits, Clean Air Act air permits, Resource Conservation and Recovery Act hazardous waste IDs, and Toxic Release Inventory reporters between 2004 and 2006.

Figure 7-1: Food Manufacturing in the Illinois River Watershed

Source: Data obtained from EPA's IDEA system on July 11, 2008. Query criteria include the following federal permits and identifiers: NPDES water permits, Clean Air Act air permits, Resource Conservation and Recovery Act hazardous waste IDs, and Toxic Release Inventory reporters between 2004 and 2006.

Many food processing facilities do not hold permits that are reported to the federal level, so this number does not include the entire population of food processors in the watershed. In fact, the county-level Census of Manufacturers data for 2002 shows 53 establishments in the food manufacturing sector in Benton and Washington Counties in Arkansas and Adair, Cherokee, and Sequoyah Counties in Oklahoma (Table 7-5).

Table 7-5: Number of Food Manufacturing Establishments* in the Counties of the Illinois River Watershed (2006)

State	County	Number of Food Manufacturing Establishments
AR	Benton	23
	Washington	24
OK	Adair	4
	Cherokee	2
	Sequoyah	-
Total		**53**

Sources: U.S. Census Bureau 2006 Economic Census of Manufacturing.
* North American Industry Classification System code 311

Municipalities

As of the 2002 Census, the majority of Illinois River watershed residents lived in the state of Arkansas. The three largest cities in the Arkansas portion of the watershed (Fayetteville, Springdale, and Rogers) had a combined population of over 142,000, while the largest three cities and towns on the Oklahoma side (Tahlequah, Stillwell, and Westville) had a combined population of just below 20,000.

Both sides of the Illinois River watershed experienced rapid population growth between 1990 and 2000 - with Oklahoma counties growing from 15,356 to 20,623 (an increase of 25 percent) and Arkansas growing from 115,075 to 174,691 (an increase of 34 percent)†.[170] Growth in Arkansas centered on the city of Fayetteville, with the Fayetteville Municipal Statistical Area growing 13.2 times faster than the state of Arkansas from 1990 and 2000.[171] Furthermore, an economic forecast undertaken by the University of Arkansas at Little Rock's Institute for Economic Advancement predicted continued growth in the Fayetteville Municipal Statistical Area, estimating that it will lead all Arkansas cities in terms of population growth through 2020.[172]

In 2004, urban land use in the Arkansas portion of the Illinois River watershed was 9.6 percent, which was an increase from just 6.3 percent in 1999, further demonstrating that northwest Arkansas is one of the fastest growing metropolitan areas in the United States.[173] Northwest Arkansas is also home to the headquarters of both Wal-Mart, the world's largest public corporation by revenue, and Tyson Foods, the largest meat producer in the world. The population increase, largely driven by the burgeoning poultry industry, has put additional strain on the watershed.

Due to the watershed's high current and expected growth, water treatment facilities will play an increasingly important role in the regional water recycling and conservation efforts. According to EPA's data system, there are 19 wastewater treatment plants with National Pollutant Discharge Elimination System (NPDES) Permits in the Illinois River watershed. The cities of Siloam Springs, Springdale, Rogers, Stilwell, and Fayetteville have with 'major' NPDES

* North American Industry Classification System code 311
† The cities and towns included in these statistics are: West Siloam Springs, Watts, Westville, Tahlequah, Paradise Hill, Stillwell, West Point, Siloam Springs, Gentry, Highfill, Cave Springs, Elm Springs, Rogers, Lowell, Bethel Heights, Springdale, Oak Grove, Johnson, Fayetteville, Farmington, Prairie Grove, and Lincoln.

designations[‡] (Table 7-6). Figure 7-2 maps the location of these water treatment facilities to their locations in the Illinois River watershed.

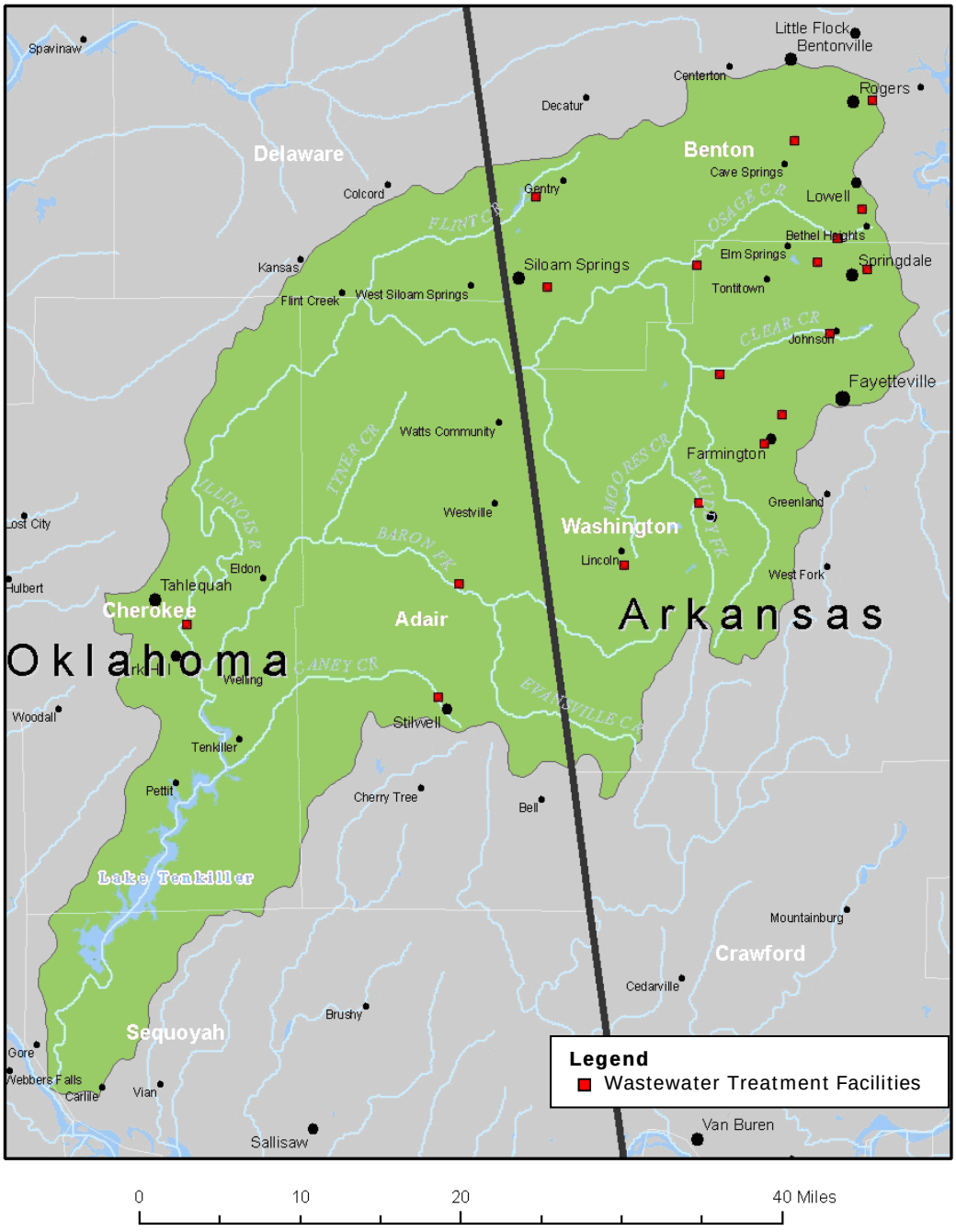
Table 7-6: Municipal Wastewater Treatment Facilities in the Illinois River Watershed

Name	City	State	NPDES Water Permit (Major / Minor)
Siloam Springs, City of	Siloam Springs	AR	Major
Springdale Water Utilities	Springdale	AR	Major
Rogers, City of	Rogers	AR	Major
Lincoln, City of	Lincoln	AR	Minor
Prairie Grove, City of	Prairie Grove	AR	Minor
Gentry WW Treatment Plant	Gentry	AR	Minor
Tahlequah Public Works Authority	Tahlequah	OK	Major
Stilwell Area Development Authority	Stilwell	OK	Major
Westville Utility Authority	Westville	OK	Minor
NW AR Conservation Authority	Tontitotown	AR	Minor
Bethel Heights, City of	Bethel Heights	AR	Minor
Elm Springs, City of	Elm Springes	AR	Minor
Farmington, City of	Farmington	AR	Minor
Springdale, City of	Springdale	AR	Minor
Washington County	Fayetteville	AR	Minor
Johnson, City of/MS4 Permit	Johnson	AR	Minor
Rogers, City of/MS4 Permit	Rogers	AR	Minor
Fayetteville/West Side WWTP	Fayetteville	AR	Major
Springdale, City of	Springdale	AR	Minor

Source: Data generated from EPA's IDEA system for Waste water Treatment Facilities on July 11, 2008. Federal permits and identifiers considered include NPDES permits, Clean Air Act air permits, Resource Conservation and Recovery Act hazardous waste IDs, and Toxic Release Inventory reporters between 2004 and 2006.

[‡] Each NPDES permit holder is defined by the program office as a Major or Minor discharger. Classification as a major discharger generally involves factors relating to the significance of the discharger's impact on the environment, such as nature and quantity of pollutants discharged, character and assimilative capacity of the receiving waters, presence of toxic pollutants in the discharge, and discharger's compliance history.

Figure 7-2: Wastewater Treatment Facilities in the Illinois River Watershed



Source: Data obtained from EPA's IDEA system on July 11, 2008. Query criteria include the following federal permits and identifiers: the NPDES permits, Clean Air Act air permits, Resource Conservation and Recovery Act hazardous waste IDs, and Toxic Release Inventory reporters between 2004 and 2006.

Impairments and Concerns in the Oklahoma Portion of the Illinois River Watershed[§]

According to the Comprehensive Basin Management Plan for the Illinois River in Oklahoma, nutrient concentrations (particularly phosphorus levels) have historically been the major water quality concern in the Illinois River watershed. In 2002 the OWRB adopted a phosphorus concentration standard for the Scenic Rivers in Oklahoma of 0.037 mg/L.[174] EPA's Section 303(d)[**] fact sheet for the Illinois River watershed lists the total phosphorus concentration as the most commonly reported cause of impairment, accounting for 50 percent of all reported impairments since 2002.[175] The increased phosphorus levels found in the watershed result primarily from "sewage treatment plant discharges and agricultural and urban/residential runoff."[176] The second-most common type of impairment for the watershed is the *Enterococcus* bacteria, accounting for 23 percent of all reports since 2002.[177]

Table 7-7 lists waterbodies and their cause of impairment as reported on Oklahoma's 303(d) Threatened and Impaired Waters List for the Illinois River Watershed.

Table 7-7: Illinois River Watershed 303(d) Threatened and Impaired Waters List, Oklahoma Portion (2006)

Waterbody Name	Cause of Impairment
Chicken Creek	Fish Bioassessments
Flint Creek	Total Phosphorus
	Enterococcus Bacteria
Illinois River	Total Phosphorus[a]
	Enterococcus Bacteria[a]
	Turbidity
Illinois River, Baron Fork	Total Phosphorus
	Enterococcus Bacteria
Sager Creek	*Enterococcus* Bacteria
	Nitrates
Tahlequah Creek (Town Branch)	*E. coli*
Tenkiller Ferry Lake	Total Phosphorus

[a] Two locations along the Illinois River are listed – the Tahlequah and Watts sections.

The Oklahoma 2006 Water Quality Assessment Report indicates that 14 of the 19 waterbodies in Oklahoma's portion of the Illinois River watershed are listed as "impaired." Table 7-8 presents a list of all the designated uses that were "impaired" as of 2006, including aesthetic, fish and wildlife propagation, and primary body contact recreation impairment.

[§] The impairments sited here represent the monitoring activities taking place in the watershed and may not reflect the complete condition of the watershed.

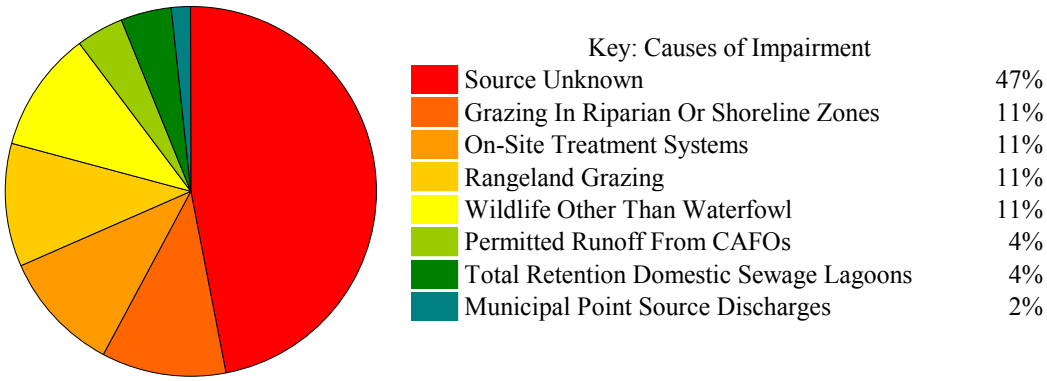
[**] The 303(d) list includes bodies of water that are impaired by pollutants (not types of pollution).

Table 7-8: Illinois River Watershed 305(b) Report, Oklahoma Portion (2006)				
Water	**Water Size**	**Units**	**Status**	**Designated Use**
Ballard Creek	12.6	Miles	Good	• N/A
Battle Creek (Battle Branch)	5.4	Miles	Good	• N/A
Caney Creek	21.1	Miles	Good	• N/A
Caney Creek	1.8	Miles	Good	• N/A
Chicken Creek	4.9	Miles	Impaired	• Fish And Wildlife Propagation – Warm Water Aquatic Community Subcategory
Flint Creek	1.6	Miles	Impaired	• Aesthetic • Fish And Wildlife Propagation – Cool Water Aquatic Community Subcategory
Flint Creek	7.8	Miles	Impaired	• Aesthetic • Primary Body Contact Recreation
Illinois River	8.4	Miles	Good	• N/A
Illinois River	7.7	Miles	Impaired	• Aesthetic • Primary Body Contact Recreation
Illinois River	32.0	Miles	Impaired	• Aesthetic • Primary Body Contact Recreation
Illinois River	15.2	Miles	Impaired	• Aesthetic
Illinois River	5.2	Miles	Impaired	• Aesthetic • Fish And Wildlife Propagation – Cool Water Aquatic Community Subcategory • Primary Body Contact Recreation
Illinois River, Baron Fork	23.3	Miles	Impaired	• Aesthetic • Primary Body Contact Recreation
Peacheater Creek	10.3	Miles	Impaired	• Primary Body Contact Recreation
Sager Creek	4.2	Miles	Impaired	• Primary Body Contact Recreation • Public And Private Water Supply
Tahlequah Creek (Town Branch)	6.2	Miles	Impaired	• Primary Body Contact Recreation
Tenkiller Ferry Lake	8,440	Acres	Impaired	• Aesthetic • Fish And Wildlife Propagation – Warm Water Aquatic Community Subcategory
Tenkiller Ferry Lake, Illinois River Arm	5,030	Acres	Impaired	• Fish And Wildlife Propagation – Warm Water Aquatic Community Subcategory
Tyner Creek	15.0	Miles	Impaired	• Primary Body Contact Recreation

Source: "Section 305(b) List Fact Sheet for Watershed – Illinois" (EPA 2008)

Figure 7-3 presents the probable sources of the pollution that led to the impairment of the waterbodies in the Oklahoma portion of the Illinois River watershed. Out of the 234 miles of assessed waters with listed causes of impairment, the largest contribution to impairment is from unknown sources (47 percent), with another 26 percent coming from agricultural sources (grazing in riparian or shoreline zones, rangeland grazing, and runoff from concentrated animal feeding operations).[178]

Figure 7-3: Probable Sources Contributing to the Impairment of Rivers and Streams in the Oklahoma Portion of the Illinois River Watershed



Source: "Section 303(d) List Fact Sheet for Watershed – Illinois" (EPA 2008). Available at: http://iaspub.epa.gov/tmdl_waters10/huc_rept.control?p_huc=11110103&p_huc_desc=ILLINOIS#WATERBODY

Impairments and Concerns in the Arkansas Portion of the Illinois River Watershed[††]

The most common causes of impairment in the Arkansas portion of the Illinois River watershed are nutrients, particularly phosphorus, and pathogens. The large concentrations of phosphorus are attributed to both point sources, such as wastewater treatment plants, and nonpoint sources, such as agricultural runoff from fertilized pastures.

Table 7-9 lists waterbodies and their cause of impairment as reported in Arkansas' 303(d) Threatened and Impaired Waters List for the Illinois River Watershed.

Table 7-9: Illinois River Watershed 303(d) Threatened and Impaired Waters List, Arkansas Portion (2004[a])

Waterbody Name	Cause of Impairment
Clear Creek	Pathogens
Muddy Fork	Total Phosphorus
Osage Creek	Total Phosphorus
Spring Creek	Total Phosphorus
Town Branch	Total Phosphorus

[a] The 2004 303(d) report is the latest reported by the State of Arkansas for the Illinois watershed.

The Arkansas 2004 Clean Water Act Section 305(b) National Assessment Database, which lists conditions of all assessed waterbodies in the state, including causes of impairment from types of pollution and likely sources of pollution, lists only one of 17 bodies of water in the Arkansas portion of the Illinois River Watershed as "impaired" (Table 7-10). As of 2004, Clear Creek had not attained the necessary water quality standards to be approved for "primary contact." Primary contact recreation is defined as activities that involve the possibility of

[††] The impairments cited here represent the monitoring activities taking place in the watershed and may not reflect the complete condition of the watershed.

total body immersion. The probable source attributed to the impairment at Clear Creek is "urban runoff/storm sewers."[179] Table 7-10 summarizes the 305(b) data for the Arkansas portion of the Illinois River watershed.

Table 7-10: Illinois River Watershed 305(b) Report, Arkansas Portion (2004[a])

Waterbody Name	Water Size (Miles)	Water Status	Designated Use
Baron Fork	10	Good	N/A
Cincinnati Cr.	9	Good	N/A
Clear Creek	13.5	Impaired	Primary Contact
Evansville Cr.	9	Not Assessed	N/A
Flint Creek	9.6	Good	N/A
Illinois River	19.9	Good	N/A
Illinois River	8.1	Good	N/A
Illinois River	1.6	Good	N/A
Illinois River	2.5	Good	N/A
Illinois River	10.8	Good	N/A
Moores Creek	9.8	Not Assessed	N/A
Muddy Fork	11	Good	N/A
Muddy Fork.	3.2	Good	N/A
Osage Creek	5	Good	N/A
Osage Creek	15	Good	N/A
Sager Creek	8	Good	N/A
Spring Creek	6	Good	N/A

[a] The 2004 305(b) report is the latest reported by the State of Arkansas for the Illinois River watershed.

Water Quality Monitoring Stations

A number of organizations routinely monitor water quality in the Illinois River watershed (Table 7-11). While many organizations focus their monitoring efforts on particular pollutants, most report to EPA's Storage and Retrieval Data Warehouse (STORET). STORET is a data management system containing water quality information for the nation's waters. Organizations operating in the Illinois River watershed that report to STORET include the OCC, which has the most monitoring stations in the area, with 102, the Cherokee Nation, EPA's National Aquatic Resource Survey (NARS), the Oklahoma Department of Environmental Quality (OKDEQ), the Arkansas Department of Environmental Quality (ADEQ), and the OWRB. The USGS National Water Information System stores water quality data of more than 1.5 million sites throughout the country and conducts monitoring for the entire spectrum of impairments as well as quantity, distribution, and movement of water parameters. The USGS has the second-highest number of monitoring stations in the watershed with 47.

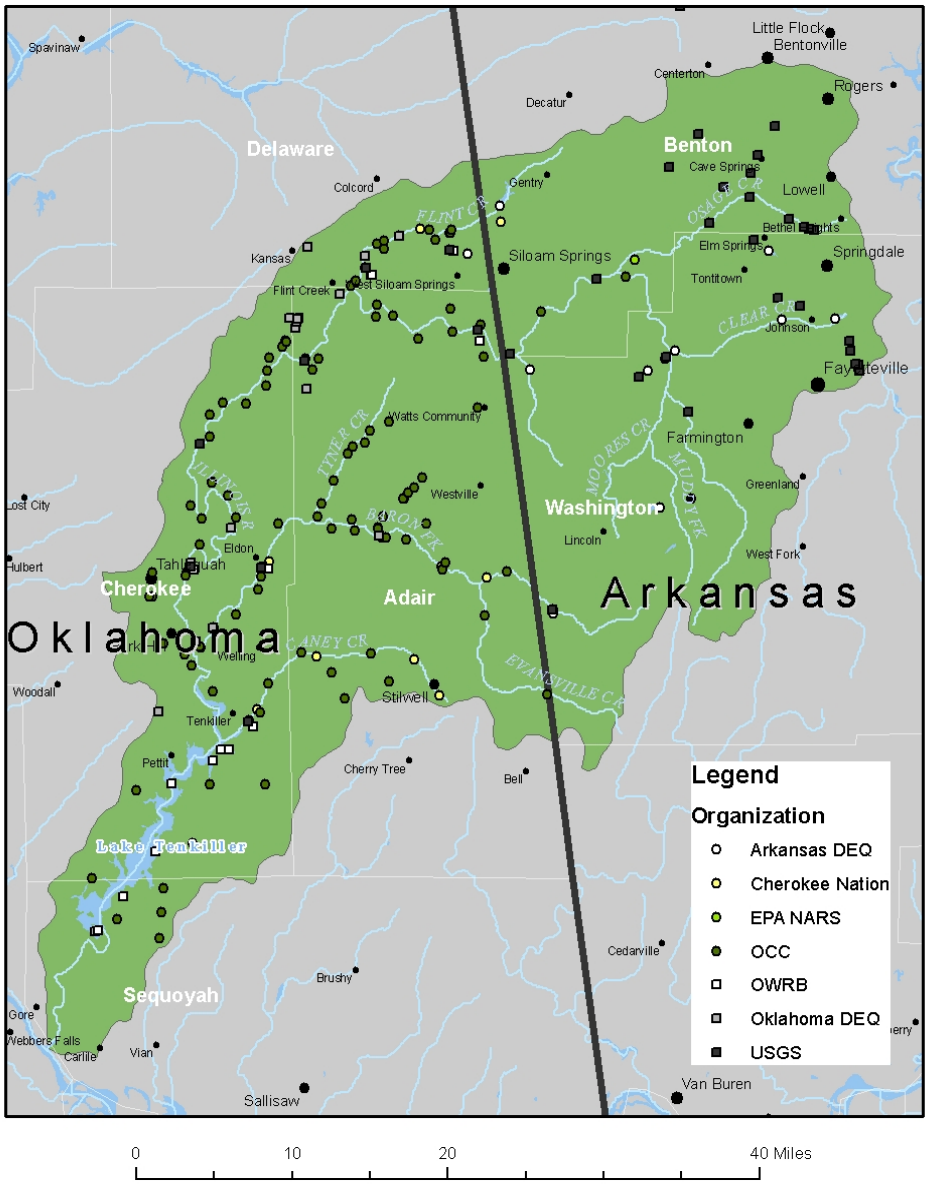
Table 7-11 Water Quality Monitoring Stations in the Illinois River Watershed[b]

USGS	ADEQ	CHEROKEE	NARS	OCC	OKDEQ	OWRB
47	15	16	1	102	22	14

[b] Monitoring stations active between 2002 to present, with at least one type of water quality parameter tested at the site. Monitoring station data collected from the USGS National Water Information System and EPA's STORET.

Figure 7-4 provides a topographical overview of the locations of water monitoring stations, by organization.

Figure 7-4: Water Quality Monitoring Stations in the Illinois River Watershed, by Organization



Source: EPA's STORET, USGS National Water Information System.

Studies and Initiatives

In general, because it is divided between two states, little information exists on the Illinois River watershed as a whole. However, both Oklahoma and Arkansas have resources describing the conditions of their portions of the watershed. The Arkansas Watershed Information System, a state-wide electronic watershed atlas provided by the Center for Advanced Spatial Technologies, provides statistical information on the Illinois River

watershed in Arkansas. Meanwhile, the OCC's Water Quality Division has a major report from 1999 summarizing the historical research undertaken on the portion of the Illinois River watershed in Oklahoma.

EPA's "Adopt Your Watershed" website reported that there were nine citizen-based groups currently active in the Illinois River Watershed. Table 7-12 presents a list of the organizations present in the watershed and a description of their activities.

Table 7-12: Summary of the Environmental Groups Active in the Illinois River Basin

Organization	Description
Save the Illinois River, Inc.	Chartered to protect the Illinois River, its tributaries, and Lake Tenkiller.
Illinois River Watershed Partnership	The Illinois River Watershed Partnership's mission is to continue to improve the health of the Illinois River through the implementation of best management practices, water quality monitoring, public education, community outreach, and ecosystem restoration activities throughout the Illinois River watershed.
Spring Creek Coalition	The Spring Creek Coalition is a nonprofit organization comprised of private landowners and citizens. The Coalition's objective is to preserve Spring Creek and its watershed through community involvement. Activities include litter clean-up, water quality monitoring and biological studies. Public meetings offer information on improved management practices for home, land, and livestock. The Coalition advocates the rights and responsibilities of landowners to protect their own natural resources.
Sierra Club – Arkansas Chapter	The Arkansas chapter of the Sierra Club encourages environmental activism, lobbying, filing suit, writing letters to editor, etc., on water quality and air quality issues, forests, urban sprawl, etc.
Oklahoma Scenic Rivers Commission	This State agency was established in 1977 in accordance with the Scenic Rivers Act. The Commission is invested with the power to establish minimum standards for planning and other ordinances necessary to carry out the provisions of the Scenic Rivers Act.
Watershed Land Trust - Oklahoma	The Watershed Land Trust is a nonprofit charitable organization opened in Oklahoma which was formed to hold land in fee simple and/or conservation easements in perpetuity.
Watershed Land Trust - Arkansas	The Watershed Land Trust is a nonprofit charitable organization opened in Arkansas which was formed to hold land in fee simple and/or conservation easements in perpetuity.
Arkansas Watershed Advisory Group	The Arkansas Watershed Advisory Group assists interested citizens and organizations by promoting local voluntary approaches to watershed management and conservation. The Group's grants have helped coordinate watershed awareness events and TMDL workshops; assisted in forming citizen-based watershed groups statewide; and helped to host a statewide watershed conference.
Oklahoma Wildlife Federation	The Oklahoma Wildlife Federation defends and encourages sustainable use of the natural resources and wildlife of Oklahoma. The Oklahoma Wildlife Federation serves as the official state affiliate of the National Wildlife Federation, tying it to the largest conservation organization in the world.

Sources: EPA. Adopt Your Watershed. Available at: http://yosemite.epa.gov/water%5Cadopt.nsf/SearchAdopt?SearchView&Query=(11110103)

The best overview of the water quality studies undertaken in the Illinois River Watershed can be found in the OCC's "*Comprehensive Basin Management Plan for the Illinois River Basin in Oklahoma*." In general, the studies were in consensus about the factors affecting the watershed. Most studies observed high levels of nutrient run-off (phosphorus, nitrogen, and chlorophyll), with non-point sources acting as the majority contributor. Table 7-13 summarizes the surveys undertaken by a variety of sources to determine the cause and nature of the water quality issues in the Illinois River watershed.

Table 7-13: Water Quality Initiatives and Studies of the Illinois River Watershed

Organization	Initiative/Study Name	Description/Findings
Oklahoma State University and University of Arkansas Cooperative	Report on Evaluation and Assessment of the Factors Affecting Water Quality of the Illinois River in Oklahoma and Arkansas (1991)	• The goal of the research was to identify trends in water quality data over time and space. • Data determined that the mean values of phosphorus were in excess of the recommended levels, with some sites being exceptionally high. The mean values of nitrite/nitrate were also high. • Estimated that 21% of the phosphorus entering Lake Tenkiller was from point sources versus 79% nonpoint.
Arkansas Soil Commission Service, Oklahoma Soil Commission Service, and the OCC	Illinois River Cooperative River Basin Resource Base Report (1992)	• Objectives were to define the water quality issues in the watershed, prioritize the bodies of water within the watershed, and develop water quality plans to address them. • Research determined that the highest priority bodies of water were generally the smaller streams, many of them tributaries of the Baron Fork Creek. • Recommendations included voluntary adoption of conservation practices, cost-share incentives to reduce waste runoff, and a strong education program to inform potential pollutant contributors.
Oklahoma Scenic Rivers Commission	River Trend Study (1996)	• Used a well-populated dataset of historic water quality samples from a variety of sites in the watershed – Data covered 120 samples collected between 1980 and 1992 • Results showed very few trends existing over the time period, and those trends that did exist weren't strong. Furthermore, the bodies of water within the watershed exhibited great fluctuations on month-to-month basis. Noted trends include the possibility that chemical oxygen demand is dropping at several sites and that turbidity is increasing. • There were no statistically significant changes in phosphorus levels, but the values were all "very high." • While a significant amount of nutrients were entering the watershed from Arkansas, Oklahoma is also contributing significantly, with data showing that "sewage treatment plant discharges (from Oklahoma) pose a major threat to the river quality."
The OCC and Oklahoma State University	Illinois River Basin – Treatment Prioritization Final Report (1995)	• Used GIS data to compare land use data and water quality information to prioritize the sub-watersheds. • Predicted sediment loading was highest from "pasture, cropland, and hay meadows." • Supported the conclusion that phosphorus is coming from the headwaters of the watershed and thus remediation should focus on this area.
OWRB and the Oklahoma State University Water Quality Research Laboratory	Clean Lakes Phase I Diagnostic and Feasibility Study of Lake Tenkiller (1994)	• Sampled eight stations between 1992 and 1993 as part of an EPA Phase I Clean Lakes Study to identify problems and recommend resolutions. • Classified Lake Tenkiller as eutrophic due to nitrogen, phosphorus, and chlorophyll levels that exceeded published standards. • The recommended course of action was to limit phosphorus loadings from source locations.
Clean Lakes Study	Determining the Nutrient Status of the Upper Illinois River Basin Using a Lotic Ecosystem Trophic State Index (1996)	• Examined Peacheater Creek, Tyner Creek, and Battle Creek. • Indicated that the light availability (in the form of turbidity) played a role in the decreased water quality in Lake Tenkiller. • Supported the conclusion that primary impacts to Lake Tenkiller appear to be derived from nonpoint sources.

Table 7-13: Water Quality Initiatives and Studies of the Illinois River Watershed

Organization	Initiative/Study Name	Description/Findings
Oklahoma State University and the OCC	Analysis of Bank Erosion on the Illinois River in Northeast Oklahoma (1997)	• Used aerial photography to measure long-term bank erosion along the Illinois River Watershed. • Estimated that around 3.5 million tons of sediment entered into Lake Tenkiller from bank erosion from 1979 and 1991. • Concluded that forested banks were 3.5 times less likely to erode than those that were only grass-covered.
Illinois River Watershed Partnership	The Riparian Project	• The Partnership is a grassroots organization that strives to improve water quality through personal endeavors and through the education, the encouragement and the positive reinforcement of fellow Illinois River Watershed residents. • Through the Riparian Project, the Partnership planted thousands of seedlings along streambanks to create riparian buffers to help preserve and protect water quality.
Arkansas National Resources Commission	Arkansaswater.org	• The mission of the Commission is to manage and protect the water and land resources for the health, safety, and economic benefit of the State of Arkansas • Arkansaswater.org compiles and shares extensive water quality information and resources on a county level utilizing latest research and GIS resources.

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