Wisconsin's Lakes at Risk

The Growing Threat of Pollution from Agriculture and Development

WISCONSIN ENVIRONMENT RESEARCH & POLICY CENTER

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Executive Summary

Runoff pollution from farms and urban areas threatens water quality in waterbodies across Wisconsin. Bacteria at beaches, toxic algae in lakes, and sediment in streams can make the water unsafe for drinking, swimming and boating, and limit aquatic plant and animal life.

The problem of manure-tainted runoff from factory farms presents a growing challenge to water quality in Wisconsin as the number of large animal-feeding operations increases. In urban areas of the state, development and construction continue to add impervious surfaces that increase the volume of unfiltered runoff entering lakes and rivers.

Wisconsin should provide adequate funding to implement new rules limiting runoff pollution into the state's lakes, rivers and streams.

Polluted runoff is responsible for much of the poor water quality across the state.

- Rain or melting snow that isn't absorbed into the ground runs off of paved areas or saturated soil into nearby streams, rivers and lakes—carrying with it a variety of pollutants, such as fertilizers, animal wastes and sediment.

- Runoff pollution contributes to the fact that 380,000 acres of Wisconsin's lakes and reservoirs and more than 3,300 miles of streams and rivers are polluted and unable to support all the activities for which we rely on water: swimming, fishing, and supporting wildlife.

A rapid increase in the number of concentrated animal feeding operations (CAFOs), which generate large amounts of manure, has increased the threat of runoff pollution.

- The number of CAFOs in Wisconsin has increased 16-fold in the past 15 years, from 10 in 1995 to almost 160 in 2010.

- More than 50 facilities keep at least 2,000 cows in one location, with each cow producing as much as 150 pounds of manure a day.

- Farmers must dispose of these huge volumes of manure. Manure is an effective fertilizer for crops, but excessive amounts applied to a field can run off into nearby streams.

Urban stormwater pollution, another major pollution source, comes from sites under construction and existing developments.

- Construction sites are responsible for more sediment pollution of Wisconsin's waters than any other source. The average construction project loses 30 tons of sediment per acre.

- From 2002 to 2007, 169,000 acres of land were developed in Wisconsin—more land than the combined areas of Milwaukee, Madison and Green Bay—disturbing soil and creating sediment pollution.

- When construction is complete, hard surfaces like rooftops and driveways funnel rain and melting snow directly to waterways without any natural filtering through vegetation. High volumes of runoff pollution during heavy rainfall can overwhelm sewer systems, spilling raw sewage directly into waterways.

Algae blooms change the ecology of lake and rivers, harming recreation and damaging wildlife.

- Blooms of algae can block sunlight from reaching other aquatic vegetation, killing native plants.

- When the algae die and begin to decay, they lower the amount of oxygen in the water, suffocating fish or causing them to flee. Nutrient pollution limits fish and other aquatic life in more than 220,000 acres of freshwater lakes and reservoirs in Wisconsin.

- Blue-green algae release a toxin that is harmful and potentially deadly for people who ingest tainted water. When blue-green algae are present, water is unsafe for swimming and other recreational purposes. Approximately 90 percent of recreation-related impairments of Wisconsin lakes and reservoirs, including Tainter Lake, are due to blooms of blue-green algae.

Sediment pollution reduces the ability of a waterway to support a full, diverse and healthy range of wildlife.

- Turbidity—high levels of suspended sediment or algae—is a problem in 150,000 acres of lakes, including the Chetek lakes.

- Runoff kills sensitive plants and animals and leaves waterways able to support only a narrow range of pollution-tolerant species, as has occurred in Lake Mendota.

Bacteria-laden runoff can make waters unsafe for recreational uses.

- In 2009, 7 percent of water samples collected at the most popular Great Lakes beaches in Wisconsin had excessive levels of bacterial pollution and beaches were closed or deemed risky for recreation 401 times.

Wisconsin needs stronger rules to curb runoff pollution into lakes, rivers, streams and aquifers, preserving clean drinking water supplies, protecting favorite swimming and boating sites, and sustaining healthy fish and wildlife populations. In the past several years, Wisconsin has taken several steps to limit pollution. Towns and cities have had to cut sediment pollution in stormwater

runoff. Farmers must comply with some restrictions on how manure is stored and applied to fields. Most recently, the state adopted a range of new standards to limit pollution from agricultural and municipal sources. To ensure the success of these new standards and to further protect the state's waters, Wisconsin should:

- Provide adequate resources for state and county agencies to implement these stronger standards protecting Wisconsin's valuable lakes, rivers and streams. The state should also increase the amount of funding available to help cover the state's share of capital improvements made by farmers to control pollution.

- Minimize urban and suburban runoff through careful site design, landscaping, and redevelopment policies.

- Reduce pollution from suspended solids in stormwater runoff.

Introduction

On a calm spring day, Tainter Lake presents an inviting blue contrast to the green hills surrounding it, drawing visitors and residents to its shores. Yet by the end of the summer, as one resident told the Associated Press, living by Tainter Lake is "like living in the sewer for three weeks. You gag. You cannot go outside."[1]

During warm weather, blooms of blue-green algae periodically turn the lake pea-soup green. When the algae die, the stench of decay fills the air and conditions in and around the lake become unbearable. Blue-green algae can release toxins into the water that cause skin irritation or respiratory problems.[2] The toxins released by the algae can also affect liver or neurological function.[3] Wisconsin officials recommend that residents near Tainter Lake protect themselves by closing their windows and not walking along the edge of the lake.[4] Swimming and boating are out of the question. The water can be fatal for pets, which must be kept away from it.

Tainter Lake's algae blooms are fueled by the flow of phosphorus washing off farm fields and developed land into the waterways that feed the lake. But while Tainter Lake's problems with blue-green algae are extreme, the lake is not alone in feeling the effects of runoff pollution.

Across Wisconsin, runoff pollution threatens the health of our treasured rivers and lakes. In some cases, much like Tainter Lake, nutrient pollution from suburban lawns and farm fields causes algae blooms that harm fish and can sicken people. In other cases, sediment from construction sites smothers fish and plant habitat. In still other cases, pavement and other impervious surfaces channel so much rainwater into combined sewer systems that those systems overflow – causing bacterial pollution that renders water unsafe for swimming.

There are solutions to Wisconsin's runoff pollution problems. At Tainter Lake, for example, the Wisconsin Department of

Natural Resources has identified strategies to reduce phosphorus pollution, including greater use of no-till agriculture, testing soil for phosphorus content before spreading additional manure, and reducing manure spreading in the winter.[5]

Practical, common-sense steps such as these can curb the flow of runoff into Wisconsin's treasured rivers and lakes. The time has come to build on the solid first steps the state has already taken to address runoff pollution, so that we can prevent the emergence of new threats and restore our waterways to health.

Runoff: What It Is and Where It Comes From

Wisconsin residents cherish our lakes and streams. Whether we use them to ice-fish in the wintertime, swim or boat in the summer, or simply value them for providing clean water to communities and healthy habitat for wildlife, we understand that clean water is a vital part of our quality of life.

Yet water pollution leaves many lakes, streams and rivers across the state too polluted for swimming or fishing, or to sustain healthy ecosystems. More than 3,300 miles of streams and rivers and 380,000 acres of lakes and reservoirs are too polluted to sustain their "designated uses"—swimming, fishing, or providing a healthy habitat for aquatic plants and animals.[6] More than 40 percent of the lake acreage evaluated by the state of Wisconsin is considered to be in fair or poor condition.[7]

Pollutants in Runoff

Runoff pollution is one of the biggest sources of water pollution in Wisconsin. It can contain bacteria from manure and raw sewage; sediment washed from bare soil; unwanted nutrients, like phosphorus and nitrogen, found in fertilizers and manure; and ammonia from manure.

Rain or melting snow can carry fertilizer, pesticides, animal wastes and soil from agricultural land into nearby lakes and streams. Tilling fields for row crops and careless spreading of manure increase runoff problems. In developed areas, water runs off rooftops, roads, parking lots and lawns, carrying oil, sediment, chemicals, fertilizer, pet waste, fallen air pollution, and other pollutants into waterways. Especially heavy rainfall may overwhelm sewage treatment systems, causing them to spill raw or partially treated sewage.

Runoff Pollution Comes from Factory Farms and Development

There are several sources of the polluted runoff that taint Wisconsin's drinking water supplies, recreational areas, and the waterways on which wildlife depends.

Two of the biggest sources are agriculture—particularly factory farms—and stormwater from developed areas.

Factory Farms

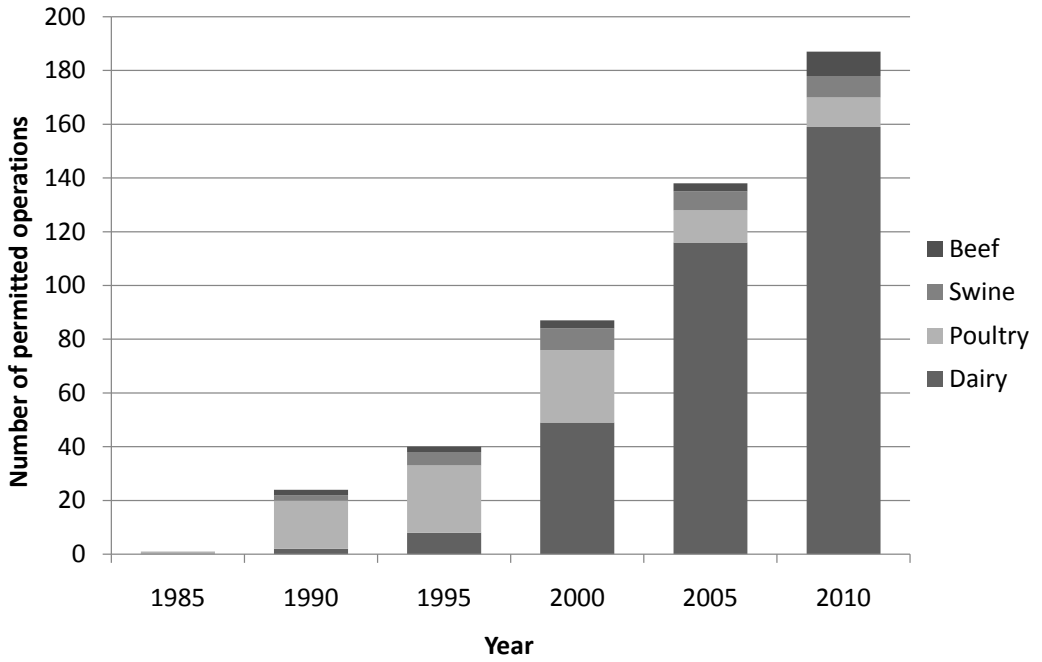
Pollution from factory farms with large numbers of livestock is a growing source of water contamination in Wisconsin. Livestock operations produce large quantities of manure that can cause nutrient and bacterial pollution in waterways.

Manure can be a valuable source of nutrients to support robust crops. Manure contains phosphorus, nitrogen and potassium, essential nutrients for plant growth.[8] For centuries, farmers have used manure as a fertilizer for their crops, collecting waste from the few animals they kept for their family or for the local market and spreading it on nearby fields. Today, farmers continue to use manure as fertilizer because it is less expensive than commercial fertilizers.

Over the past several decades, however, farming in Wisconsin has undergone a dramatic shift from family farms to factory farms. The growth of large-scale livestock facilities—and the amount of manure they generate—means that many farmers have more manure available than they can safely and usefully spread on fields. A family farmer with a small herd of cows or a modest-sized flock of chickens can profitably use manure or barn waste as fertilizer. In contrast, a big dairy operation generates so much manure that getting rid of it becomes a problem for the farmer and a threat to water quality. With a larger quantity of manure, the good practices that keep manure out of waterways—such as not spreading it too close to the edge of a field—are harder to follow.

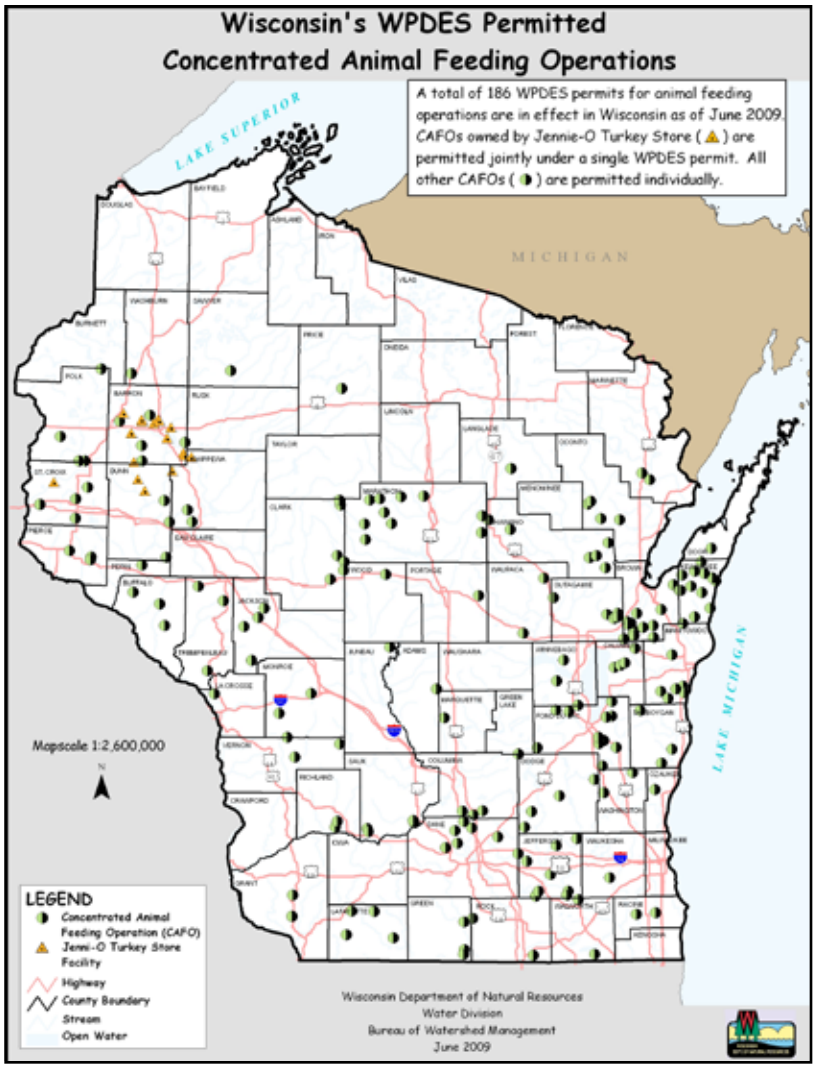
The number of large-scale animal-raising operations, known as concentrated animal feeding operations (CAFOs), has increased dramatically in Wisconsin in

Figure 1. Number of Permitted CAFOs by Year[12]



Note: The number of poultry operations in the state has not declined. The Department of Natural Resources changed how it permitted poultry facilities operated by Jennie-O Turkey Store in 2002. Multiple facilities are now covered by one permit.

Figure 2. CAFOs Are Located Across Wisconsin[13]



the past 15 years. In Wisconsin, a facility is considered a CAFO if it has 700 dairy cows, 1,000 beef cattle, 55,000 turkeys, or 100,000 laying chickens.[9] In 1995, fewer than 10 dairy operations were large enough to be considered CAFOs. Ten years later, in 2005, nearly 120 locations were identified as CAFOs, and by 2010 that figure had risen to nearly 160.[10] (See Figure 1.) Most of the CAFOs in Wisconsin are dairy operations, and of those, more than 50 have at least 2,000 cows in one location.[11] CAFOs are located in counties across the state. (See Figure 2.)

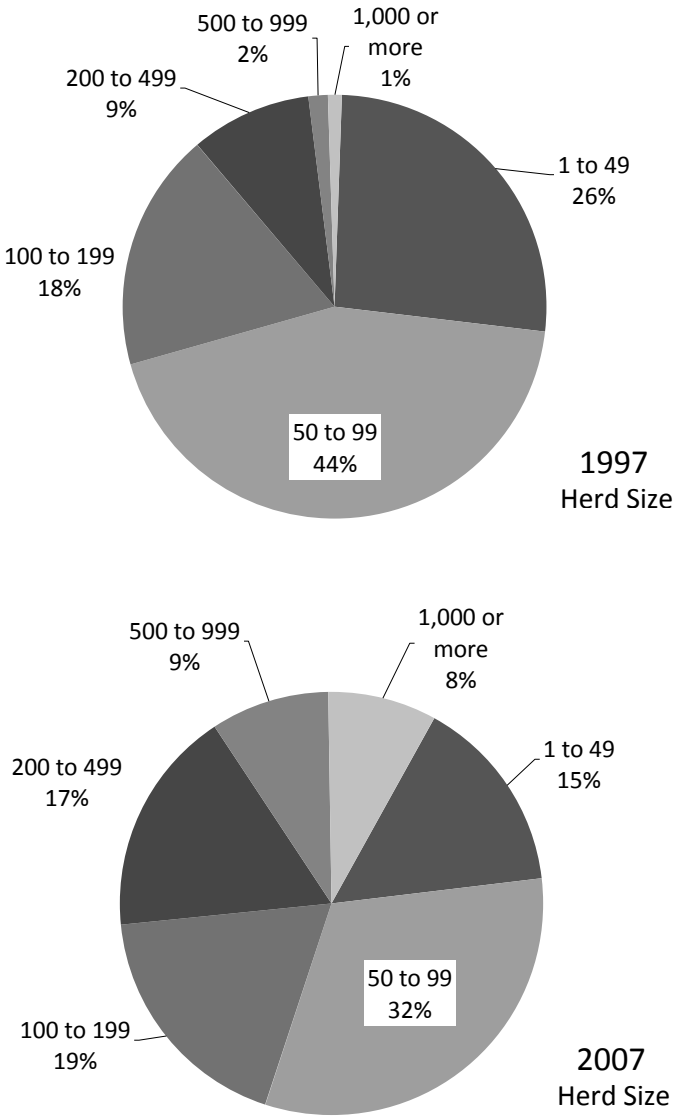
Large operations that do not quite meet the threshold for regulation as CAFOs have increased also. From 1997 to 2007, the percentage of cows in herds with fewer than 200 dairy cows declined by one third, while the percentage of cows in herds of 200 to 499 cows increased by 71 percent.[14] (See Figure 3.) The number of cows in herds of 500 to 999—which may or may not be regulated as CAFOs—increased even faster, rising 450 percent.

Given that a single dairy cow can produce 150 pounds of manure a day, an operation with 700 cows generates 105,000

pounds of manure every day, or as much pollution as could be produced by 12,600 people.[16] This also means that facilities that are not technically CAFOs can nonetheless produce large amounts of pollution.

The Wisconsin Department of Natural Resources (DNR) lists pollution from CAFOs with water pollution permits as a contributing factor in the degradation of several lakes and rivers around the state.[17] Phosphorus pollution from CAFOs pollutes the Red Cedar River and Tainter Lake in Dunn County, feeding blooms of toxic algae. CAFOs produce bacterial pollution in Sheboygan County's Otter Creek, limiting the use of that stream for recreation. Phosphorus and sediment in Neshonoc Lake are causing eutrophication, overfertilization that causes excessive aquatic plant growth. See Appendix B for the full list of waterways impaired by livestock-related activities.

Figure 3. Big Dairy Herds Have Become More Common Since 1997 (percent of cows by herd size)[15]



Runoff from smaller animal feeding operations pollutes lakes and rivers, too. In Brown and Outagamie counties, pollution from animal feeding operations adds phosphorus and ammonia to Dutchman Creek, compounding other pollution problems that have led to chronic aquatic toxicity for fish and other animals and low levels of dissolved oxygen.

Development

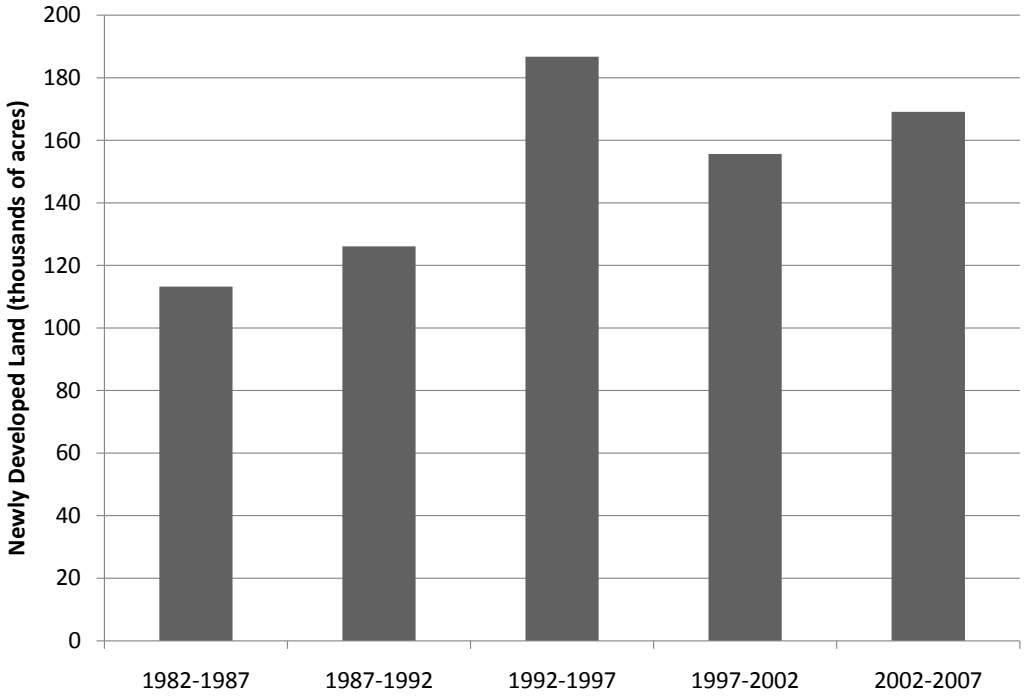
Development is another major source of runoff pollution in Wisconsin, affecting communities across the state. The construction of new roads and buildings disturbs the landscape, impairing its ability to soak up water and increasing the amount of sediment that runs off. Even when the construction phase is over, runoff pollution problems continue as those new facilities direct greater amounts of water directly into streams and waterbodies.

Pollution During Construction

At the beginning of construction, all plants are stripped from a site so that the land can be leveled and graded. Drainage ditches or storm sewers might be built as part of the site's basic infrastructure, before buildings and parking lots are completed. Then, the soil sits bare and exposed to rain and melting snow for the duration of construction. Without plants to slow it down, water flows more quickly, eroding the soil, which may have phosphorus attached to it. Drainage ditches efficiently carry that sediment and phosphorus pollution into streams.

While agricultural activities can also produce sediment pollution, construction sites are responsible for more sediment pollution of Wisconsin's waters than any other source. The average construction project delivers 30 tons of sediment into nearby waterways for every acre under

Figure 4. New Land Development in Wisconsin[23]



development.[18] In contrast, an acre of cropland loses one to 10 tons annually.[19]

According to recent data compiled by the DNR, sediment pollution is a widespread problem afflicting Wisconsin's waterways. Sediment contributes to the impairment of 1,800 miles of rivers and streams and 183,000 acres of inland lakes, including Lake Winnebago.[20]

Land development—and the sediment pollution that results—has occurred at a rapid clip for years. (See Figure 4.) From 2002 to 2007, 169,000 acres of land have been developed in Wisconsin, or 34,000 acres per year.[21] That's bigger than the combined areas of the cities of Milwaukee, Madison and Green Bay.[22]

Pollution After Construction

Extensive development has an impact on water quality even after construction is completed. Development covers natural land with impervious surfaces—roads, driveways, roofs and other hard surfaces that prevent rainwater and snowmelt from being absorbed directly into the ground.

The amount and location of impervious surface in watersheds is closely connected to the health of downstream waterways. Watersheds with a large amount of forested cover, a large riparian buffer, and low levels of impervious surface tend to have better water quality. Water quality problems tend to become apparent when 5 to 10 percent of a watershed is covered with impervious surfaces. Adding more impervious surface leads to more serious water quality problems.[24] When a watershed is developed to the point where 15 percent or more of the land is impervious, water quality degradation accelerates quickly.[25]

Impervious surfaces generate runoff pollution. Rooftops and paved surfaces typically are designed with gutters and drains to channel rain and melting snow away from the development and straight into sewers or creeks. This direct route of runoff into waterways means there is no opportunity for vegetation or soil to filter out pollutants.

Runoff from developed areas can contain sediment, toxics, salt, pet and wildlife wastes, oil, organic material and other contaminants. Common toxics include pollutants from vehicles, including lead and zinc, which are hazardous to human health and can kill aquatic life.[26] Pesticides are also common in urban runoff. A million gallons of water draining from a commercial area will contain 1,500 pounds of suspended solids, 2.6 pounds of phosphorus, 31 pounds of nitrogen, and 3.3 pounds of toxic metals.[27]

Bacterial contamination can occur when high volumes of water runoff from developed areas overwhelm combined sewage and storm sewer systems. Unlike natural areas, streets, sidewalks, parking lots and buildings do not absorb any water; instead, these impervious surfaces channel water toward streams and storm sewers. In cities with antiquated combined sewage and storm sewer systems such as Milwaukee, the high volume of water that enters the system during storms can be overwhelming, causing the release of raw or partially treated sewage.

Pet and wildlife wastes also can generate bacterial pollution. A 2001 to 2003 study of fecal contamination in the water at Lake Michigan's South Shore Beach near Milwaukee found that much of the pollution came from waste left by ring-billed gulls and waterfowl on paved areas near the boat ramp. A paved parking lot the size of two city blocks drained down the boat ramp into the lake, depositing fecal material directly into the water.[28]

Runoff Fouls Wisconsin's Waterways

With nearly 3 percent of the state covered in lakes, Wisconsin has abundant fish and aquatic animal populations, and offers lots of opportunities for water recreation.[29] Both swimming and boating are popular pastimes – Wisconsin, for example, has roughly 500,000 registered motorboats in the state, or nearly one for every 11 residents.[30] However, runoff pollution reduces the ability of waterways to support a full, diverse and healthy range of wildlife. It also limits recreational opportunities.

Nutrient Pollution Creates Algae Blooms

Nutrients found in manure and fertilizer, such as phosphorus and nitrogen, can help crops grow, but when those nutrients are carried into waterways they promote growth of aquatic vegetation where it might not normally occur. This vegetation degrades waterways.

In unpolluted lakes and streams, lack of phosphorus typically limits plant growth.[31] When phosphorus is added, algae flourish. Even a small amount of phosphorus pollution can trigger algae growth: a single pound of phosphorus can support the growth of 500 pounds of algae.[32]

In waters across the state, blooms of blue-green algae, or cyanobacteria, limit recreation.[33] At 99 percent of reservoirs and 91 percent of freshwater lakes that are listed as impaired, blue-green algae were the cause of the recreation-related impairment noted by the Department of Natural Resources. People who are exposed to blue-green algae can suffer a variety of health consequences, including stomach cramps, vomiting, diarrhea, difficulty breathing, fever and muscle weakness.[34] Blue-green algae also present a threat to dogs, causing illness or death.[35]

The presence of large amounts of algae, whether blue-green algae or other varieties, changes the ecology of the waterbody. Algae floating near the surface block sunlight from reaching aquatic plants in deeper water, stifling their growth or killing them. When the algae die and decay, they cause concentrations of dissolved oxygen in the water to plummet. If oxygen levels are too low, aquatic vegetation fails to thrive,

while fish must flee or they will suffocate. Ultimately, the most sensitive plants and animals are killed or forced to move, leaving behind only a narrow range of pollution-tolerant species.[36] This process affects more than 220,000 acres of freshwater lakes and reservoirs in Wisconsin.[37]

Nutrient Pollution Case Study: Algae Blooms on Lake Mendota

Lake Mendota is a central feature of Madison. Downtown Madison and the Wisconsin state capitol grounds lie on an isthmus between Lake Mendota and Lake Monona. The 22-mile-long shore of Lake Mendota is lined with parks, boat launches, private homes, and the University of Wisconsin campus.[38]

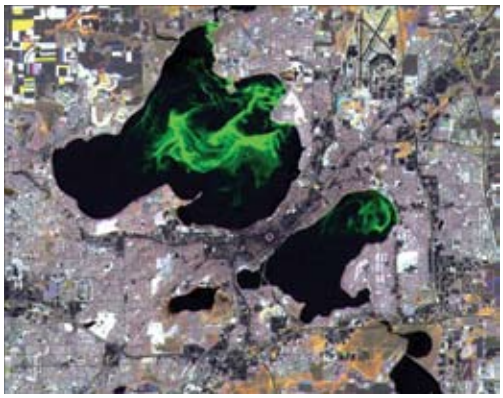
Pollution has marred Lake Mendota, limiting its use as a recreation site and its ability to support a fully functioning ecosystem. The biggest source of pollution in Lake Mendota is from farms and livestock operations located in the lake's 217-square-mile watershed.[39] This pollution enters the Yahara River, which delivers excessive sediment and nutrients to the lake. Some previous sources of pollution, such as untreated sewage, have been eliminated, but other sources of pollution persist, including erosion from construction sites and stormwater runoff from paved areas. The pollution flows both directly into Lake Mendota and into its tributaries. Accidental spills remain a problem, too, such as a 2005 manure spill in Dorn Creek.[40]

This pollution has changed the ecology of the lake. Many native plant species such as wild celery, slender naiad, water crowfoot, muskgrass and several varieties of pondweed have dwindled or been eliminated entirely.[41] Some species of fish have disappeared, too, including banded killifish, blackstripe topminnow, blackchin shiner, and others. The lake still supports a variety of sport fish, including walleye, perch, bass, panfish and muskellunge.[42]

Another consequence of phosphorus and nitrogen pollution is algae blooms, such as of toxic blue-green algae.

In 2008, an 18-year-old University of Wisconsin student became ill after swimming in Lake Mendota during a blue-green algae bloom. She received treatment in the emergency room, but four days after swimming, the student was still experiencing an upset stomach, a rash, joint pain, a headache, and fatigue.[43] The student swam

Lake Mendota in the fall, as viewed from University Bay Landing. Credit: Daniel J. Simanek



A satellite image of Lake Mendota (larger lake) and Lake Menona, surrounded by Madison. The swirls are algae blooms, digitally highlighted to make them easier to see. Credit: UW SSEC and WisconsinView.

with friends at a swimming area popular with University of Wisconsin students; a lifeguard employed by the university keeps watch over the swimming area during the day. Because the ill student swam after dark, the blue-green algae bloom wasn't visible.

In the broader Madison area, blue-green algae blooms sickened at least four people in the summer of 2008, including the owner of a lake-front home who cleaned weeds from the water.[44]

Water quality in Lake Mendota has begun to improve. In 1980, the water was so clouded with sediment that aquatic plants could not grow in water deeper than 7 feet because they did not receive enough sunlight.[45] In recent years, however, plants have been able to return to depths as great as 16 feet thanks to clearer water. Yet fully restoring Lake Mendota will require more work. As of 2000, the Lake Mendota watershed contained so much excess phosphorus that it would require three centuries with no additional phosphorus pollution to return the watershed to normal levels.[46]

In 2010, Dane County received a grant to conduct soil testing on 7,500 acres of farmland in the Lake Mendota watershed.[47] The results of the soil tests should help reduce pollution from agricultural sources. Test data will help farmers better calibrate the amount of fertilizer that they apply to their fields and reduce nutrient pollution that ends up in Lake Mendota.

Sediment Harms Fish and Aquatic Plants

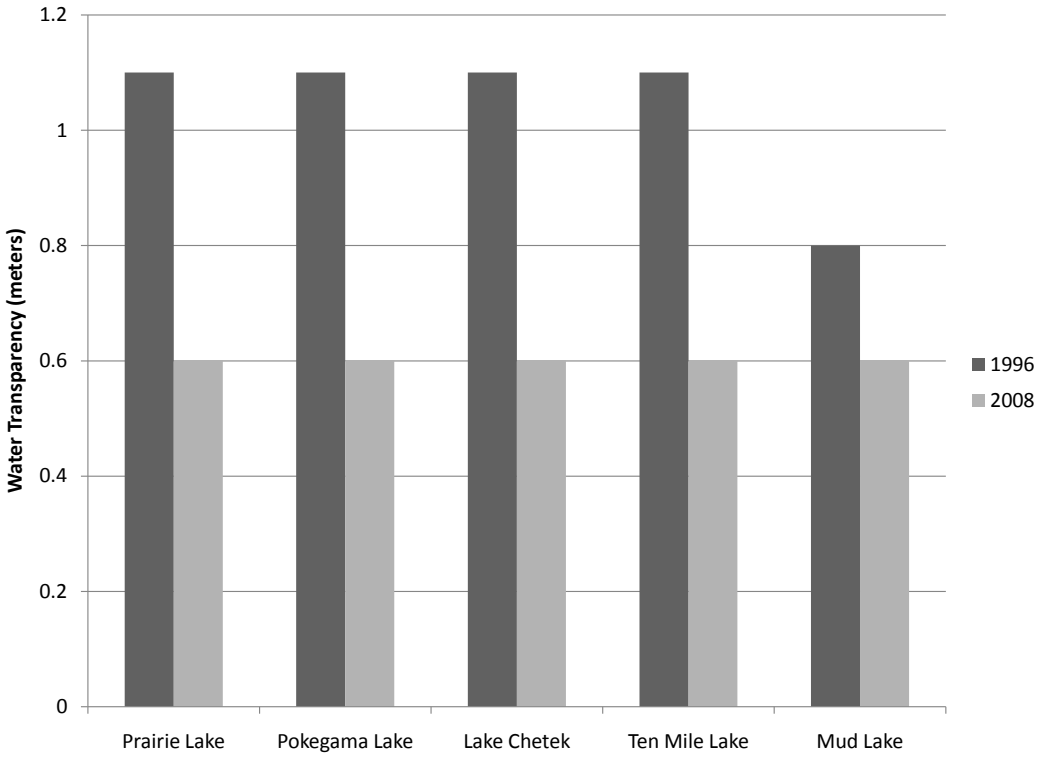
Sediment pollution narrows the range of plants and animals able to survive in a waterway. Sediment can smother aquatic vegetation, insects, fish eggs, or newly hatched fish.[48] As sediment accumulates in streams, it can cover gravel bars that provide habitat for spawning fish. Ultimately, if enough sediment is deposited in a stream, it can alter the flow of water, leading to streambank erosion.[49]

When suspended in the water, sediment reduces water clarity and limits how much light reaches aquatic plants, retarding growth. Silty streams may also become warmer as the dark soil retains more of the sun's heat, potentially raising the water temperature to unhealthy levels for fish.[50] High sediment levels affect 150,000 acres of lakes in Wisconsin.[51]

Turbidity Case Study: Declining Water Clarity in the Chetek Lakes

The Chetek Lakes—Prairie Lake, Mud Lake, Pokegama Lake, Lake Chetek and Ten Mile Lake, in Barron County—have become more polluted in the past decade. The lakes contain high levels of phosphorus, which support excessive algae and invasive species such as curlyleaf pondweed. This growth can deprive fish of oxygen and impair water clarity that can harm native plants. Measurements of water transparency taken in 2008 show that all the lakes are much cloudier than they were in 1996.[52] (See Figure 5.)

Figure 5. Water Clarity Has Declined in Chetek Lakes Since 1996[53]



No major industrial facility drains into the lakes; rather, nearly half the phosphorus in the lakes comes from cropland, with much of the rest coming from livestock operations and perhaps increased recycling of phosphorus already in the lake.[54] Manure that is washed off feedlots or off fields where it has been spread as fertilizer adds phosphorus to the lakes. Particles of soil eroded from plowed fields add both phosphorus and sediment pollution. Phosphorus that isn't carried downstream eventually settles into sediment at the bottom of the lake, and if that sediment is disturbed the phosphorus can feed the growth of a new generation of algae.

Fish killed by manure that ran off a frozen field. Credit: WI DNR.

Ammonia in Manure Kills Fish

The slow build-up of nutrient and sediment pollution isn't the only way that runoff pollution harms fish. A sudden influx of manure-laden runoff can kill fish almost instantly, as the ammonia in manure damages the gills of fish.[55] In a 12-month period

in 2004-2005, DNR received reports of 59 incidents where manure entered waterways and in more than a dozen of those cases caused fish kills.[56] (See photo on p. 15.)

Bacterial Pollution Closes Beaches

Along Lake Superior and Lake Michigan, Wisconsin residents have access to the water at 192 beaches, with a total of 55 miles of beach.[57] However, bacterial pollution at these beaches often makes swimming unsafe.

Overflows from combined sanitary and storm sewers periodically pollute Wisconsin waters. In the summer of 2010, heavy rain caused the combined sanitary and storm sewers in Milwaukee and 10 other municipalities to overflow.[58] In June 2009, several sewer systems in the Milwaukee area overflowed after the area received as much as six inches of rain.[59] Nearly 1 billion gallons of raw sewage were dumped into local waterbodies. Just a year earlier, heavy rainfall caused almost 3 billion gallons of sewage to enter waterways.

Sewage introduces bacterial pollution to water, increasing the risk that people who come in contact with the water or ingest it will get sick. In 2009, 7 percent of water samples collected at the most popular Great Lakes beaches had excessive levels of bacterial pollution.[60] Each positive test result triggered either a prohibition on swimming until bacterial levels declined, or an advisory to swimmers to avoid ingesting lake water, to shower after swimming, or to wash hands after swimming and before eating.[61] Some closings occurred and advisories were issued when there was strong reason to expect a test, which can take up to 24 hours to complete, would come back positive. Table 1 shows the number of closings and advisories by county.

Table 1. Bacterial Pollution at Wisconsin's Great Lakes Beaches in 2009[62]

County	# of Beaches Where Water Was Sampled	Number of Days with Closings or Advisories
Ashland	7	7
Bayfield	16	0
Brown	3	3
Door	31	126
Douglas	12	2
Iron	5	0
Kenosha	5	32
Kewaunee	2	4
Manitowoc	9	9
Milwaukee	11	109
Oconto	0	0
Ozaukee	7	41
Racine	2	8
Sheboygan	8	60
Statewide	**118**	**401**

Bacterial and Nitrate Pollution from Manure Can Enter Groundwater

In addition to polluting streams and lakes with bacteria and nutrients, manure can also taint groundwater that is used for drinking water.

The problem is particularly common in northeast Wisconsin, which is known for having karst topography, where fractured bedrock is covered by only a small amount of soil. As a result, the groundwater is vulnerable to contamination.[63] In contrast, in other areas of the state, soil is deep enough to filter out contaminants from nitrogen and bacteria in manure and septic systems that are present on the surface, keeping the groundwater clean. In the northeast Wisconsin counties of Brown, Calumet, Door, Kewaunee and Manitowoc, however, soil depth ranges from a mere couple of inches to a few feet, allowing water that has been barely filtered to find its way into aquifers. Sinkholes, fractured rock and rock outcroppings can allow surface runoff to flow directly into groundwater. Repeatedly, manure produced by the thousands of cows raised in northeastern Wisconsin has entered groundwater, polluting drinking water wells and water supplies.

The town of Morrison, in Brown County, supports 41,000 dairy cows that produce a total of 260 million gallons of manure annually.[64] That manure frequently is spread on nearby fields as fertilizer. In 2006, Brown County experienced an early thaw. Just days after temperatures turned upward, the thawing of manure-covered fields resulted in coliform bacteria, E. coli, and nitrate pollution in more than 100 wells.[65] Residents who drank or bathed in the water suffered from various ailments including diarrhea, stomach pains and ear infections.

Tests of private drinking water wells in Kewaunee County from mid-2004 to mid-2006 showed significant contamination.[66] Of the 173 wells that were tested, nearly one fifth had bacterial contamination—likely from manure-tainted runoff—that made the water unsafe for human consumption. Nitrate pollution, which can come from manure or fertilizer, affected more than half the wells: 18 percent had nitrate levels that exceeded the health standard for drinking water, and another 35 percent had nitrate levels above background levels but below the level that threatens human health.

The bacterial pollution from manure may include antibiotic resistant bacteria. A study of surface and groundwater below a swine feedlot found higher levels of bacteria and a higher percentage of antibiotic resistant bacteria than in waters upstream from the feedlot.[67] Livestock in CAFOs often are treated with antibiotics to help them grow faster and to limit the spread of disease between animals kept in such close quarters. This overuse of antibiotics can lead to bacteria that are resistant to antibiotics. People who become ill from water polluted with resistant bacteria may be more difficult to treat and be sick for longer.

Field-spreading of manure is not the only source of water pollution. Poor manure management by farmers also can be a problem. The state recently settled a lawsuit with the Gold Dust Dairy in Brown County for allowing its manure pit to overflow into a nearby waterway and for storing other manure in a three-sided building that allowed manure to run off. In addition to promising to fix the problems, the dairy had to pay an $80,000 fine to implement and enforce the new regulations.[68]

Policy Recommendations

Effective action is needed to reduce runoff pollution and restore Wisconsin's waterways to health.

In recent years, Wisconsin has taken several steps to limit runoff pollution. In 2002, Wisconsin passed a law to reduce pollution from stormwater. The law requires municipalities to reduce the volume of total suspended solids in their stormwater runoff by 20 percent by 2008 and by 40 percent by 2013.[69] That legislation also required improved pollution control from construction sites and farms. Farmers were required to reduce manure runoff if the state subsidized 70 percent of the cost of improvements to contain pollution. More recently, the state adopted a ban on phosphorus in lawn and golf course fertilizer, which should lower the amount of nutrients getting into waterways.

Despite this progress in recent years, too much pollution still makes its way into Wisconsin's lakes, rivers and streams, leading to massive algae blooms, limiting aquatic biodiversity, and causing other problems. New sources of pollution threaten the state's waters, as the number of factory farms in Wisconsin has tripled in the last decade and new development continues to add impervious surfaces.[70]

Wisconsin needs strong action to curb runoff pollution into lakes, rivers, streams and aquifers, preserving clean drinking water supplies, protecting favorite swimming and boating sites, and sustaining healthy fish and wildlife populations.

In 2011, the state adopted a set of rules to better protect waterways. The rules include:

- A science-based phosphorus standard for soils. If a field already has enough phosphorus to support healthy crop growth, any additional phosphorus that is applied to the field in the form of manure or fertilizer is likely to run off into nearby waters. If a farmer chooses to meet a crop's need for nitrogen by applying manure, the field will likely receive excessive levels of phosphorus. To comply with a phosphorus standard, farmers will need to perform a simple soil test before applying more phosphorus.

  Soil testing is important because even if a farmer is being careful about how and when manure is applied to fields,

it is still possible to inadvertently apply excessive amounts of manure. Manure contains a set ratio of nitrogen to phosphorus. If a farmer applies manure as fertilizer based on how much nitrogen the crop needs, the field may be supersaturated with phosphorus. For example, an acre of alfalfa may need 200 pounds of nitrogen to flourish, but just 40 pounds of phosphorus.[71] Yet if the farmer applies enough manure from a dairy lagoon to meet the crop's nitrogen need, the soil will contain far too much phosphorus. Manure from a dairy lagoon can contain 80 pounds of phosphorus for every 100 pounds of nitrogen, or 120 pounds more than a field of alfalfa needs. The excess phosphorus can be carried off the field and into nearby waterways through erosion of phosphorus-heavy soil or if it is dissolved by rainwater.

- Better control of runoff pollution from sources draining into impaired waterways.

- Buffers between streams and the plowed areas of fields. Untilled areas of grass and trees can help slow the runoff of water from a cultivated field, allowing sediments and pollutants to be filtered out. The roots of these established plants also help to stabilize stream banks and reduce pollution from erosion. A wider buffer provides greater protection, as well as better habitat for wildlife.

- Limits on runoff from feedlots, milk houses and other sources.

- Stronger limits on the acceptable amount of sediment pollution from construction sites.

- More protection for high-quality wetlands by requiring 75-foot-wide vegetative buffers between construction areas and vulnerable areas.

Manure running off a field. In the winter months, frozen soil cannot absorb the waste, and melting snow carries it into streams in the spring. Credit: WI DNR.

While these rules are a strong step for Wisconsin, there is more the state can do to protect Wisconsin's valuable lakes, rivers and streams, including strong implementation of these new rules and adopting additional protections. Wisconsin should:

- **Provide adequate resources for state and county agencies** to implement and enforce the new regulations.

- **Increase funding for capital improvements.** The state's runoff pollution regulations promise that the state will pay 70 percent of the cost of capital improvements needed by farmers to cut runoff pollution. Though the state has provided significant funding in recent years for upgrades, many opportunities for reducing pollution remain. Increased funding to upgrade agricultural and municipal pollution control systems would help reduce the flow of nutrients into Wisconsin's waterways.

- **Minimize urban and suburban runoff.** At new development locations, careful site design can help the built environment function more like the natural environment. This means including more vegetation (particularly native plants), using absorbent surfaces, and designing landscaping to slow the flow of water, allowing it to soak into the ground. Existing urban and suburban areas can be remodeled with rain gardens and a reduction in impervious surfaces, such as with more green space or the use of permeable pavement. Landscaping that allows greater absorption of precipitation often has the added benefit of creating more space for recreation and enhancing the appearance of urban areas. On a broader scale, smart growth practices reduce the area of impact and protect critical parts of the ecosystem by using strategic open spaces, infill development, town center redevelopment, and clustered, higher-density design to minimize runoff in the aggregate.

- **Address other sources of water pollution.** Municipalities should further reduce the amount of suspended solids in stormwater runoff. Under Wisconsin's 2002 law, municipalities have cut suspended solids by 20 percent compared to 2004 levels. They must continue to invest in upgrades so that by 2013, suspended solids are reduced by 40 percent compared to 2004 levels.

Appendices

Appendix A. Permitted CAFOs by County

County	Beef	Chickens	Dairy	Swine	Turkeys	Total*
Adams	0	0	1	0	0	1
Barron	0	0	5	0	1	6
Brown	1	0	16	0	0	17
Buffalo	0	0	3	0	0	3
Calumet	0	0	5	0	0	5
Chippewa	0	0	1	1	0	2
Clark	0	0	6	0	0	6
Columbia	1	1	1	0	0	3
Crawford	0	0	0	0	0	0
Dane	2	1	4	0	0	7
Dodge	1	0	3	0	0	4
Door	0	0	1	0	0	1
Dunn	0	0	3	0	0	3
Fond Du Lac	0	0	12	0	0	12
Grant	0	0	1	1	0	2
Green	0	0	3	0	0	3
Green Lake	0	0	2	0	0	2
Jackson	0	0	3	1	0	4
Jefferson	1	4	4	0	0	9
Juneau	0	0	1	0	0	1
Kewaunee	1	0	13	0	0	14
La Crosse	0	0	0	1	0	1
Lafayette	0	0	4	0	0	4

County	Beef	Chickens	Dairy	Swine	Turkeys	Total*
Langlade	0	0	2	0	0	2
Manitowoc	0	0	8	0	0	8
Marathon	0	0	9	0	0	9
Marinette	0	0	2	0	0	2
Marquette	0	0	1	0	0	1
Monroe	0	0	3	0	0	3
Oconto	0	0	3	0	0	3
Outagamie	0	0	6	0	0	6
Ozaukee	0	0	1	0	0	1
Pepin	0	0	1	0	0	1
Pierce	0	0	3	0	0	3
Polk	0	0	3	0	1	4
Portage	0	0	1	0	0	1
Price	0	0	1	0	0	1
Racine	0	0	0	0	0	0
Richland	0	0	1	1	0	2
Rock	0	0	1	1	0	2
Sauk	1	0	0	2	0	3
Sawyer	0	0	1	0	0	1
Shawano	0	0	6	0	0	6
Sheboygan	0	0	5	0	0	5
St. Croix	1	0	3	0	0	4
Trempealeau	0	0	3	0	0	3
Vernon	0	0	2	0	0	2
Walworth	0	1	1	0	0	2
Washburn	0	0	1	0	0	1
Washington	0	1	1	0	0	2
Waukesha	0	1	0	0	0	1
Waupaca	0	0	2	0	0	2
Winnebago	0	0	3	0	0	3
Wood	0	0	1	0	0	1
Total	**9**	**9**	**167**	**8**	**2**	**195**

* Note: Operations with more than one type of animal can show up multiple times.
Source: Wisconsin Department of Natural Resources, *WDNR Runoff Management: CAFO Permittees*, downloaded from http://dnr.wi.gov/runoff/agriculture/cafo/permits/cafo_sum.asp, 28 June 2010.

Appendix B. Waters Polluted by Runoff from Livestock Operations

Most of the impaired waters in Wisconsin are polluted by multiple sources.
The table below highlights livestock-related pollution only.

Waterbody Name	County	Runoff-Related Pollutants
Apple Creek	Brown, Outagamie	Phosphorus, Sediment
Ashwaubenon Creek	Brown	Phosphorus, Sediment
Babb Creek	Sauk	Sediment
Bacon Branch	Grant	Sediment
Beaver Dam River	Dodge	Phosphorus, Sediment
Becky Creek	Rusk	E. coli, Sediment
Black River (Hwy H To Rock Creek)	Clark	unknown
Blue River	Iowa	Sediment
Bower Creek	Brown	Phosphorus, Sediment
Buell Valley Creek	Buffalo	Sediment
Coon Creek	Dunn	Sediment
Culver Branch	Grant	Sediment
Dutchman Creek	Brown	Phosphorus, Ammonia
Dutchman Creek	Outagamie	Phosphorus, Ammonia
Eagle Creek	Buffalo	Sediment
East River	Brown, Calumet	Phosphorus, Sediment
Finley Lake	Chippewa	Phosphorus, Sediment
Irish Valley Creek	Buffalo	Sediment
Johnson Coulee Creek	La Crosse	Sediment
Johnson Creek	Jefferson	Sediment
Joos Valley Creek	Buffalo	Sediment
Little Lake Wissota	Chippewa	Phosphorus, Sediment
Long Coulee Creek	La Crosse	Sediment
Louisburg Creek	Grant	Sediment
Martin Branch	Grant	Sediment
Martinville Creek	Grant	Sediment
Missouri Creek	Dunn	Sediment
Moon Bay	Chippewa	Phosphorus
Neenah Slough	Winnebago	Phosphorus
Neshonoc Lake	La Crosse	Phosphorus, Sediment
North Branch of Pike River	Kenosha, Racine	Sediment, unknown
North Creek	Trempealeau	Sediment
Otter Creek	Sheboygan	E. coli
Pheasant Branch	Dane	Phosphorus, Sediment
Prairie Lake	Barron	Phosphorus
Printz Creek	Monroe	Sediment
Red Cedar River	Dunn	Phosphorus
Roaring Creek	Jackson	Sediment
Rock River	Rock	Phosphorus, Sediment
Rogers Branch	Grant	Phosphorus, Sediment
Silver Lake	Manitowoc	Phosphorus
Steel Brook	Jefferson	Phosphorus, Sediment
Stevens Creek	Rock	Sediment
Tainter Lake	Dunn	Phosphorus
Tappen Coulee Creek	Trempealeau	Sediment
Trump Coulee Creek	Jackson, Trempealeau	Phosphorus, Sediment
Willow River (140 Ave to 100th St.)	Saint Croix	Phosphorus
Yahara River	Dane, Rock	Phosphorus, Sediment
Yeager Valley Creek	Buffalo	Sediment

Impact of Pollution	Livestock-Related Sources of Pollution
Low dissolved oxygen, Elevated water temperature, Degraded habitat	Livestock grazing or feeding
Low dissolved oxygen, Degraded habitat	Livestock grazing or feeding
Degraded habitat	Livestock grazing or feeding
Degraded habitat	Livestock grazing or feeding
Low dissolved oxygen, Degraded habitat	Permitted runoff from CAFOs
Degraded habitat, Recreational restrictions	Livestock grazing or feeding, Dairy operations
Low dissolved oxygen	Dairy operations
Degraded habitat	Livestock grazing or feeding
Low dissolved oxygen, Degraded habitat	Livestock grazing or feeding
Degraded habitat	Livestock grazing or feeding
Elevated water temperature, Degraded habitat	Livestock grazing or feeding
Degraded habitat	Livestock grazing or feeding
Chronic aquatic toxicity, Low dissolved oxygen	Livestock grazing or feeding
Chronic aquatic toxicity, Low dissolved oxygen	Livestock grazing or feeding
Degraded habitat	Livestock grazing or feeding
Chronic aquatic toxicity, Low dissolved oxygen, Degraded habitat	Livestock grazing or feeding
Eutrophication, Degraded habitat	Livestock grazing or feeding
Degraded habitat	Livestock grazing or feeding
Degraded habitat	Livestock grazing or feeding
Degraded habitat	Livestock grazing or feeding
Degraded habitat	Livestock grazing or feeding
Eutrophication	Livestock grazing or feeding
Degraded habitat	Livestock grazing or feeding
Degraded habitat	Livestock grazing or feeding
Degraded habitat	Livestock grazing or feeding
Degraded habitat	Livestock grazing or feeding
Degraded habitat	Livestock grazing or feeding
Eutrophication	Livestock grazing or feeding
Low dissolved oxygen	Livestock grazing or feeding
Eutrophication	Permitted runoff from CAFOs
Chronic aquatic toxicity, degraded habitat	Dairy operations
Degraded habitat	Livestock grazing or feeding
Recreational restrictions	Permitted runoff from CAFOs
Low dissolved oxygen, Degraded habitat	Livestock grazing or feeding
Degraded habitat	Permitted runoff from CAFOs
Degraded habitat	Livestock grazing or feeding
Eutrophication	Permitted runoff from CAFOs, Livestock grazing or feeding
Degraded habitat	Livestock grazing or feeding
Low dissolved oxygen, Degraded habitat	Livestock grazing or feeding
Low dissolved oxygen, Degraded habitat	Livestock grazing or feeding
Fish kills	Livestock grazing or feeding
Low dissolved oxygen, Elevated water temperature,	Livestock grazing or feeding Degraded habitat
Degraded habitat	Livestock grazing or feeding
Eutrophication	Permitted runoff from CAFOs
Elevated water temperature	Livestock grazing or feeding
Low dissolved oxygen, Degraded habitat	Livestock grazing or feeding
Low dissolved oxygen	Livestock grazing or feeding
Low dissolved oxygen, Degraded habitat	Livestock grazing or feeding
Degraded habitat	Livestock grazing or feeding

Source: *2010 Impaired Waters List with Sources* (spreadsheet), provided by Matt Rehwald, Wisconsin Department of Natural Resources, personal communication, 19 July 2010.

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