BEYOND THE STATUS QUO:

2015 EQB Water Policy Report

LAKE ST. CROIX

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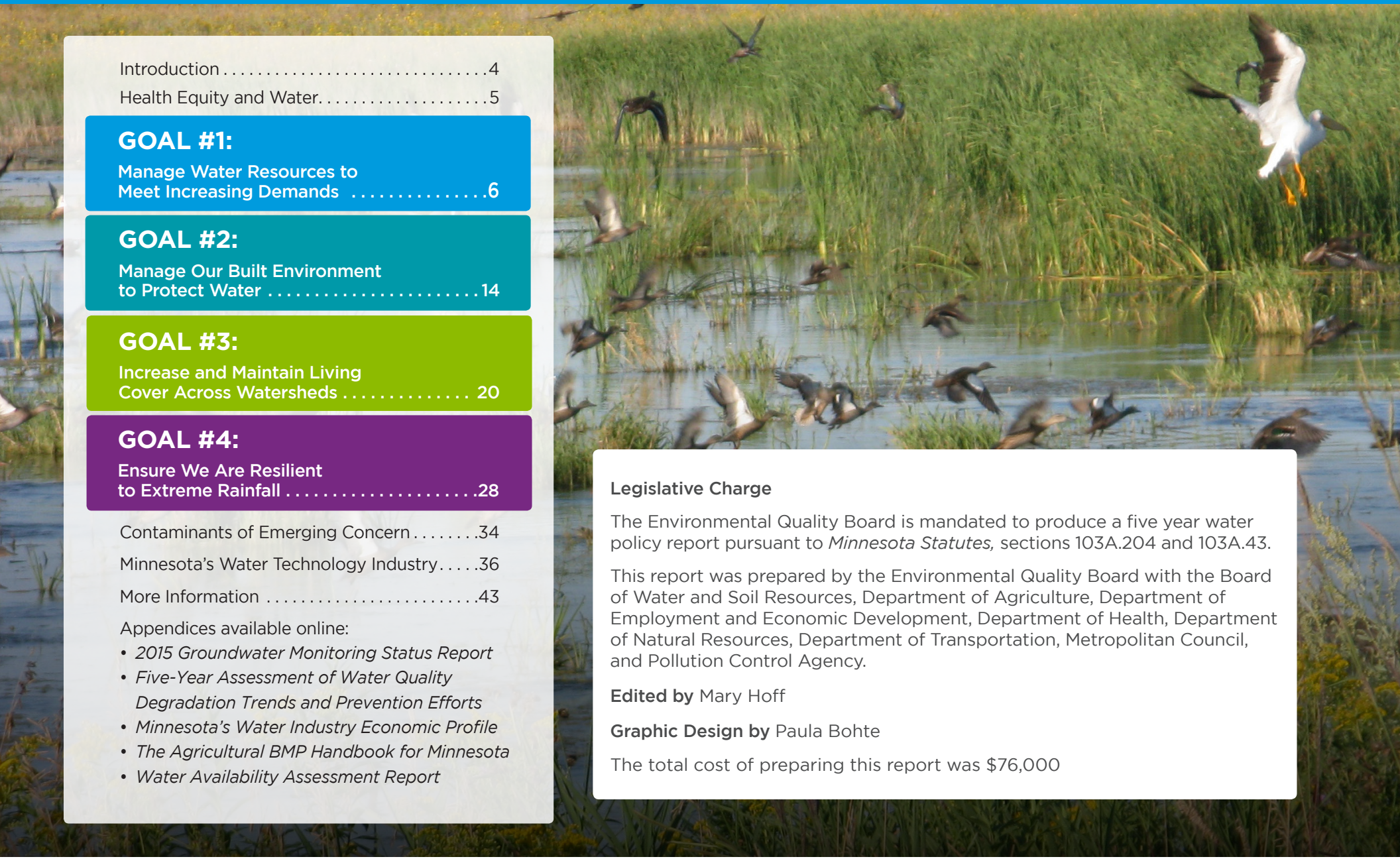

Legislative Charge

The Environmental Quality Board is mandated to produce a five year water policy report pursuant to *Minnesota Statutes,* sections 103A.204 and 103A.43.

This report was prepared by the Environmental Quality Board with the Board of Water and Soil Resources, Department of Agriculture, Department of Employment and Economic Development, Department of Health, Department of Natural Resources, Department of Transportation, Metropolitan Council, and Pollution Control Agency.

Edited by Mary Hoff

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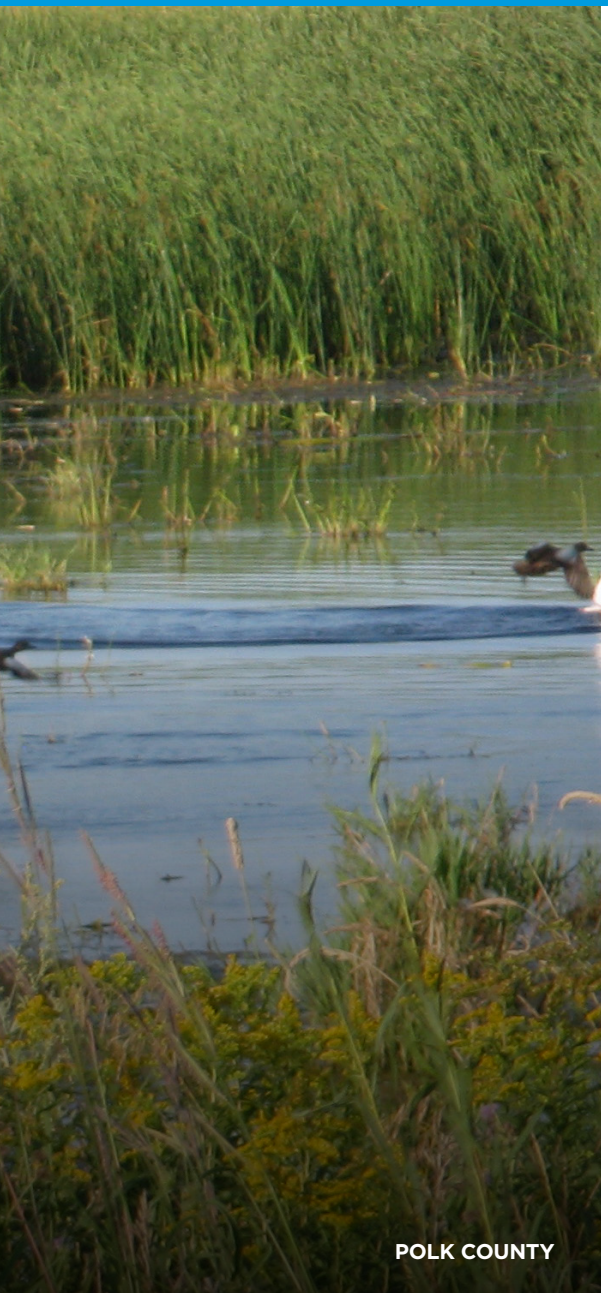
The total cost of preparing this report was $76,000


POLK COUNTY

Minnesota is home to more than 10,000 lakes, 100,000 miles of rivers and streams, and abundant groundwater resources. However, many of these waters are not clean enough. In 2015, we took a major step toward improving our water by enacting a law that protects water quality by requiring buffers on more than 100,000 acres of land adjacent to water.

This legislation builds on the commitment we made in 2008 to protect drinking water and restore waterways with the passage of the Clean Water, Land and Legacy Amendment. Since that time, we created Minnesota's Clean Water Roadmap with clear targets to guide our efforts. We continue to measure our progress in the biennial Clean Water Fund Performance Report. We are thinking more holistically about protecting drinking water, preserving habitat and maintaining recreational opportunities. The resulting coordination across state and local governments makes us better stewards of our lands.

Access to clean water is not just a Minnesota issue. It is a national and global concern, and Minnesota is well-positioned to address it as a global leader in the clean water industry. Minnesota ranks in the top 10 nationally for patents and exports of services and products that increase water use efficiency, allow us to reuse water and help us treat water to make it safe to drink. This leadership results from synergy among our state's entrepreneurs, cutting-edge research and development, a world-class university system, and a critical mass of industries.

Minnesotans are rightly proud of these accomplishments. However, as a headwater state for three major waterways, we also recognize we have more work to do. In too many places our investments only maintain the status quo, which is simply not good enough. To ensure that Minnesota's fish are safe to eat, that our water is safe to drink and our lakes are safe for swimming, we need to do a better job. Clean water is a cornerstone of our state's economy and a vital resource for our citizens. Let's work together to guarantee a healthy water legacy for future generations.

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INTRODUCTION


LAKE ELMO

This report is organized as a menu of options to move beyond the status quo on water challenges Minnesota faces. It was developed and written by state agencies with the intent of providing a framework to continue a broad conversation on water policy with local and state implementation partners. The layout acknowledges that water challenges and solutions are interrelated and that the solutions described here are only some of the possible approaches to meet the following goals:

#1: Manage water resources to meet increasing demands

#2: Manage our built environment to protect water

#3: Increase and maintain living cover across watersheds

#4: Ensure we are resilient to extreme rainfall

How we use land affects our water

The choices landowners make on the landscape determine whether it is able to hold the soil, absorb rainfall and filter nutrients. Our choices in the built environment affect how water drains off roads and other impervious surfaces, carrying contaminants that can impair water quality. In many cases today's consequences were affected by choices made decades ago. And the choices we make today will affect future Minnesotans for decades to come. The impacts of these choices are further compounded by weather extremes that threaten health, safety and property.

How we use land affects others' water

Minnesota is home to the headwaters for three of the largest drainage basins in North America. This means that the way we manage our water affects many others downstream. Minnesota set goals to reduce pollutants leaving the state as follows:

- **Gulf of Mexico:** reduce nitrogen and phosphorus 45 percent from the 1980–1996 baseline
- **Lake Winnipeg:** reduce nitrogen by 13 percent and phosphorus by 10 percent from the 2003 baseline
- **Lake Superior:** maintain 1979 conditions for phosphorus and continue nutrient management programs

How we use our lands can result in real costs

Building in floodplains and human changes to watersheds that increase runoff combine to increase flood damages. Pollutants make public waters unfit for swimming or fishing. Contamination and decreased recharge of aquifers create uncertainty in our water supplies. We are already spending millions of dollars to rebuild after floods, clean up contaminated wells and build new treatment facilities to meet our water supply needs. We are losing places to fish, hunt and recreate due to lower water levels and lost wetland habitats. One way or another there are costs, and we eventually pay a price. It is more economical to prevent problems than to clean up after they occur.

Minnesota's water technology industry

Minnesota is a global leader in production of technology to treat, reuse and conserve water. This leadership results from the synergy of our entrepreneurs, cutting-edge research and development, a world-class higher education system, and a cluster of innovative industries. As we work to prevent further degradation, we need to continue to foster an economic sector that will produce solutions to future challenges.

Four types of solutions to change the status quo:

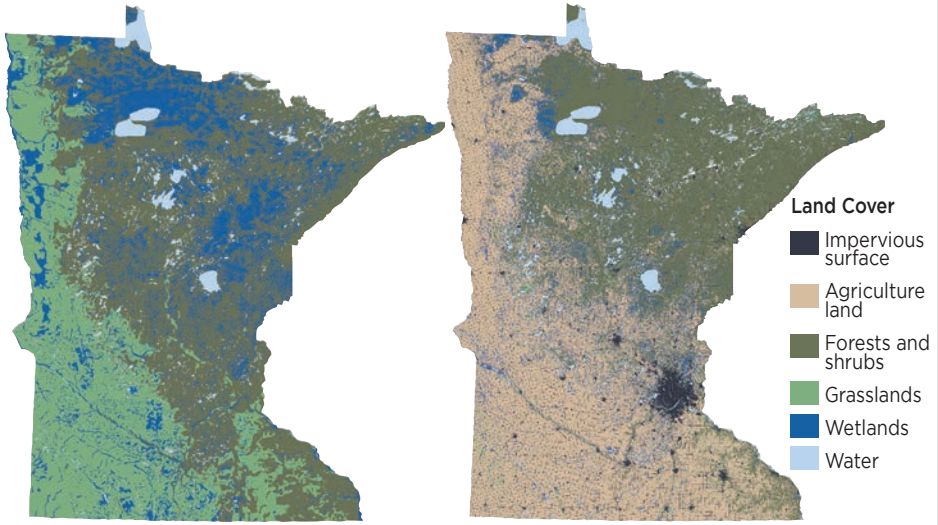
Voluntary Put the tools and resources into the hands of Minnesotans. These solutions often include incentives, outreach to encourage voluntary action or public discussion of trade-offs and goals.

Regulatory Create laws, regulations and/or guidelines. Implementation includes permit requirements, monitoring, codes and standards.

System change Identify and work to change the status quo through market forces, cultural expectations, governance models and management structures.

More study Propose additional research or monitoring where more information is needed. Studies could include developing new technology, monitoring water or land use, or social science to understand cultural barriers.

Minnesota's land cover has changed dramatically since European settlement.



Pre-European settlement

Today's land cover

Health Equity and Water

In Minnesota, everyone depends on water for drinking, fishing or recreating. Access to clean, abundant water for these purposes contributes to overall health and well-being. Yet certain populations face conditions that prevent them from attaining their highest possible level of health. Health inequities are socially determined circumstances and are possible to change.

Safe Drinking Water

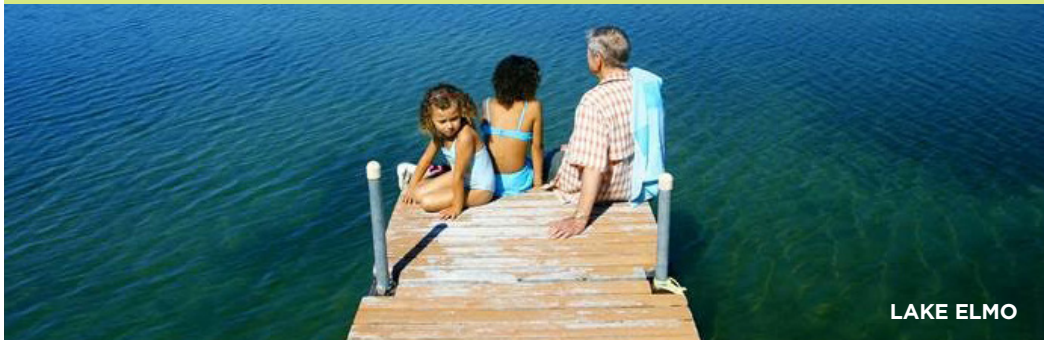
- Rural communities have fewer people to share the cost of drinking water services and face unique issues such as pollution from agriculture and inadequate sewage infrastructure.
- Private well owners facing financial, language or educational barriers may be less likely than others to test or treat their well for contaminants.
- The elderly and children are at highest risk for illness from contaminated drinking water.

Fishing

- Some American Indian, poor and minority groups consume high rates of fish and types of fish that increase the risk from contaminants.
- Young children, developing fetuses and breast-fed babies are at most risk from mercury in fish because small amounts can damage a brain that is just starting to form or grow.

Recreating

- Urban poor have limited access to water recreation due to poverty, safety and walkability of neighborhoods, distance from parks and lakes, and transportation limitations.



LAKE ELMO

Goal #1: Promote Sustainable Water Use


WILLIAM O'BRIEN STATE PARK

Manage water resources to meet increasing demands

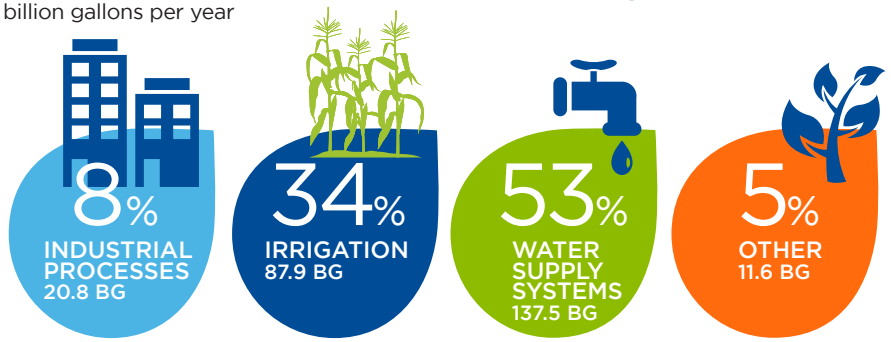
As Minnesota's population and economy grow, so does our use of water. In particular, groundwater use has increased 35 percent over the past 25 years, and use continues to increase. This trend may not be sustainable.

Parts of Minnesota are vulnerable to groundwater shortages due to high pumping or population growth combined with overreliance on a single water source. Minnesota is not yet in crisis, but we see warning signs in some areas where groundwater supply is at risk of depletion. Overuse of groundwater can also harm surface waters that depend on it, such as trout streams and wetlands.

Groundwater pumping can introduce or move contaminants. Water moves easily through sands and the cracks in karst areas, making the groundwater underneath the sandy soils of central Minnesota and the karst of southeastern Minnesota particularly sensitive to pollution. Groundwater and surface water are interconnected, so depletion or contamination of groundwater can affect surface water as well.

Groundwater Uses in Minnesota in an Average Year (2011)

billion gallons per year

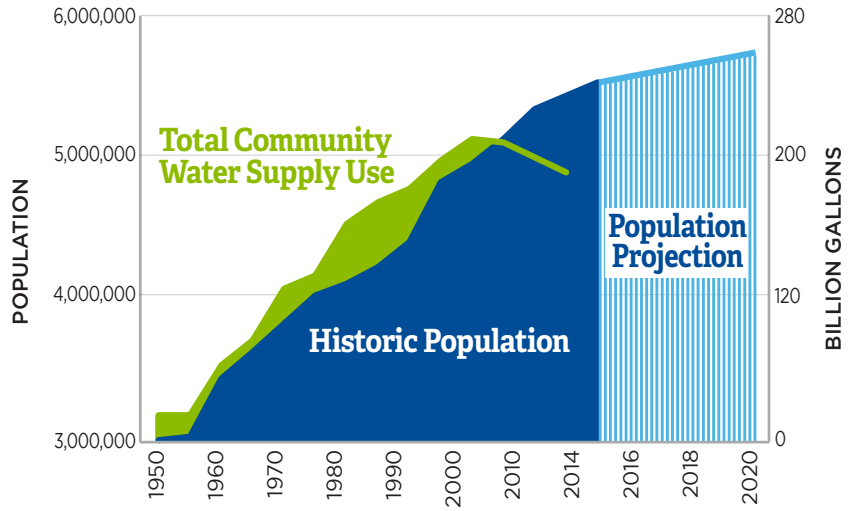



MINNEAPOLIS

Groundwater systems are complex and largely unseen. Because water can move very slowly underground, impacts of today's actions may take months or years to appear and years or decades to resolve.

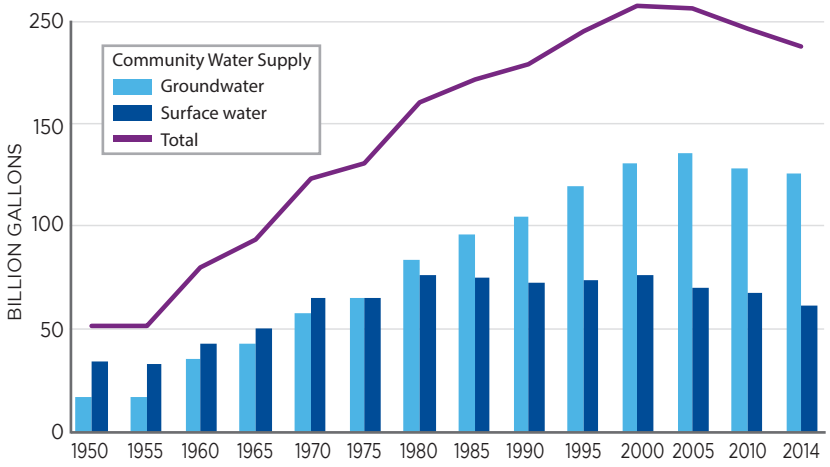
The Minnesota Department of Natural Resources requires an appropriation permit for anyone who uses, removes or transfers more than 10,000 gallons per day or 1 million gallons per year of surface water or groundwater. In evaluating permit requests, the department considers the best available information, including whether permits meet a sustainability standard established in state statute: "that the groundwater use is sustainable to supply the needs of future generations and the proposed use will not harm ecosystems, degrade water, or reduce water levels beyond the reach of public water supply and private domestic wells..." (*Minnesota Statutes*, section 103G.287, subd. 5).

Minnesota Population and Water Trends



SOURCE: MNDNR & MN STATE DEMOGRAPHIC CENTER

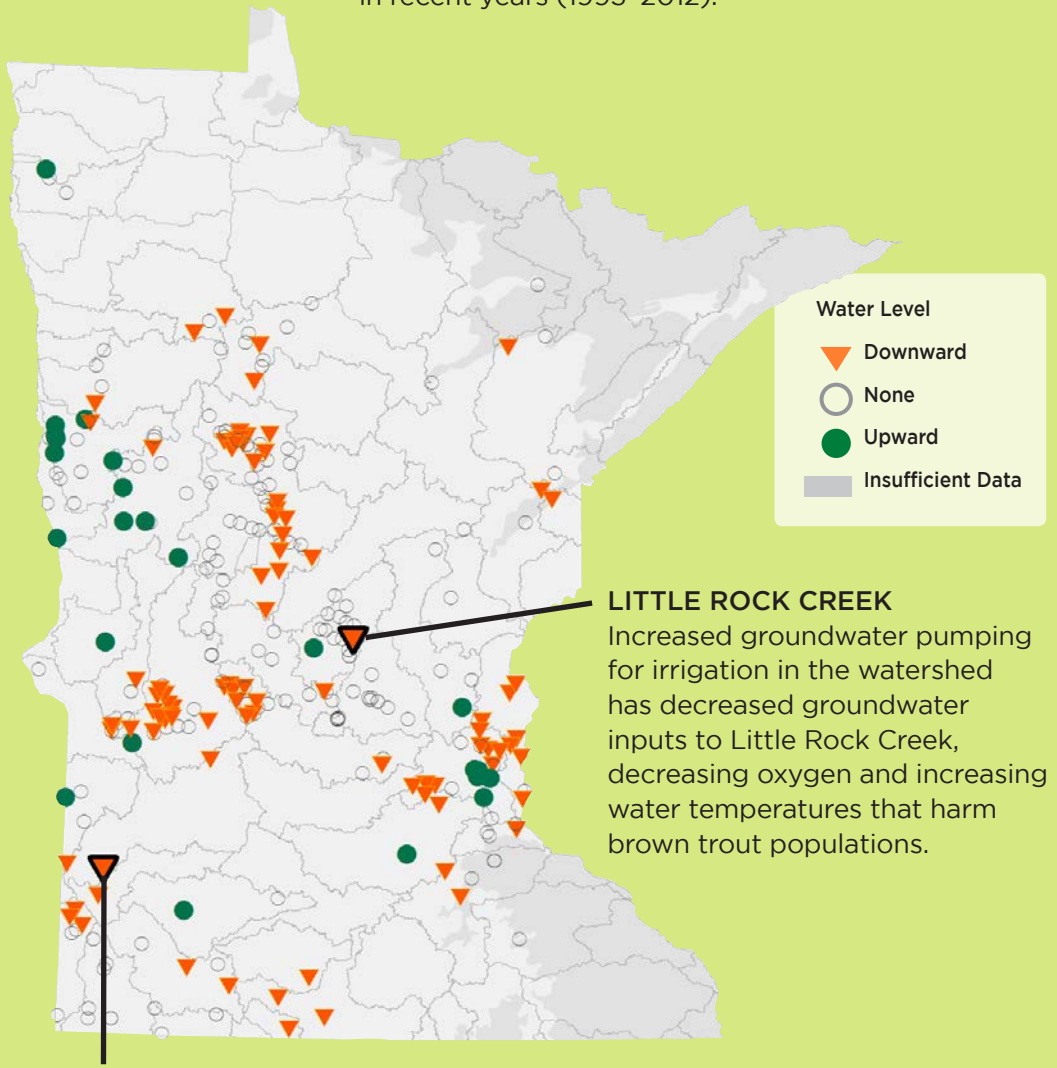
Changes in Water Sources Over Time



SOURCE: MNDNR

Well Water Level Trends

While not all of Minnesota has water supply issues, numerous wells have shown a decrease in water level in recent years (1993–2012).



LITTLE ROCK CREEK
Increased groundwater pumping for irrigation in the watershed has decreased groundwater inputs to Little Rock Creek, decreasing oxygen and increasing water temperatures that harm brown trout populations.

REDWOOD RIVER AREA
Declining aquifer levels are causing water supply issues for communities, industry and wildlife areas along the Redwood River.

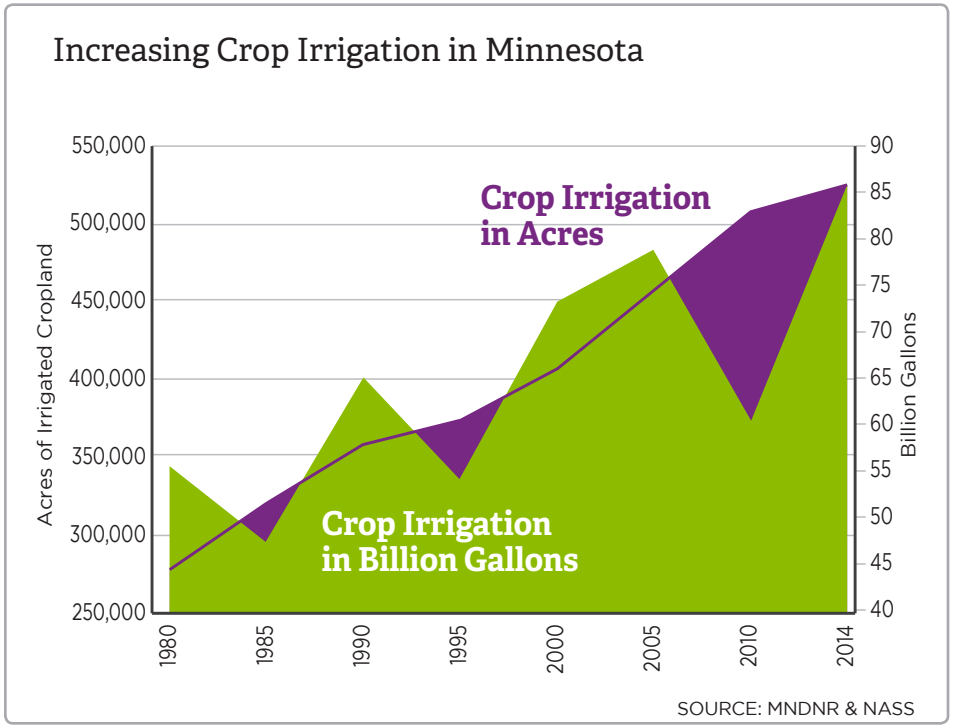
SOURCE: MNDNR

Voluntary Solutions

Use agricultural irrigation water more efficiently

Many farmers have adopted low-pressure irrigation, and most new center-pivot irrigation systems have low-pressure systems attached, making them an industry standard. The incentive for irrigators is not only more efficient water application, but also energy savings resulting in lower utility costs. This is just one example of success for water conservation in Minnesota; many other water conservation efforts are also underway.

The use of precision weather data to estimate crop water needs has great potential to further boost efficiency. A network of weather stations provides information such as precipitation, air temperature, air humidity, wind speed and solar radiation. Irrigators use this information to determine if, when and how much to water crops. In partnership with local governments, the Minnesota Department of Agriculture has 11 operating weather station sites. The Minnesota Department of Natural Resources plans to install an additional 50.



Improve industrial water efficiency

Minnesota's ample clean water attracts and retains many industries. While water itself is relatively inexpensive, the energy that goes into pumping, heating and treating it is costly. Inefficiencies in industrial processes and equipment can waste water and the energy used to pump and heat it. Increasing water efficiency not only saves companies money, it can also benefit the community that shares those water resources, making it a win-win for the bottom line and the environment.

Water-intensive industries in the Twin Cities metropolitan area use some 8.5 billion gallons of water per year from their own wells. In the summer of 2012, the Metropolitan Council and the Minnesota Technical Assistance Program sponsored three engineering interns to spend a summer at three industries focusing on water conservation. The three interns identified opportunities to save more than 44 million gallons of water per year.

Water Saved From Increased Industrial Efficiency

	Gedney Pickles	Federal Cartridge	Northern Star Foods
2012 water use (gal)	94,666,800	87,156,500	121,656,000
Minnesota Technical Assistance Program–identified annual water savings (gal)	6,400,000	30,600,000	7,000,000
Annual water savings as % of total use	6.8%	35.1%	5.8%
Annual $ savings	$94,800	$57,480	$166,300

Regulatory Solution

Update plumbing codes and treatment standards to allow for safe and practical water reuse

Water withdrawn from Minnesota aquifers, streams and lakes is rarely reused, even though the water (or treated wastewater) remaining after use is clean enough to be reused for industrial and agricultural purposes. This single-use habit puts unnecessary pressure on water supplies.

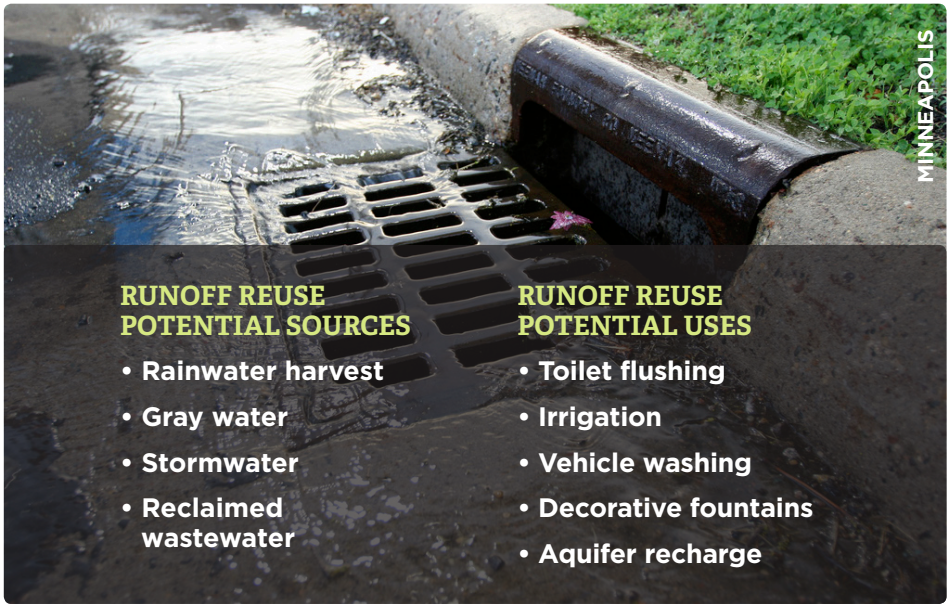
Water reuse can reduce demand on water resources, but we need clear standards to address public health and environmental concerns. Federal guidelines for implementing reuse safely are largely absent, leaving regulation up to state and local governments. Minnesota lacks a comprehensive, statewide approach to guide municipalities, industries and others interested in water reuse. To make this an option, codes and guidelines need to be revised or created. An interagency work group is identifying gaps in current regulation and assessing the safety and practicality of reuse options.

SUCCESS STORY

Mankato Wastewater Reuse

When Mankato Energy Center built a 1,000-megawatt natural gas–fired power plant 10 years ago, it chose to use treated wastewater rather than groundwater for cooling. The center paid the wastewater treatment plant to install phosphorus removal equipment and in return received a 20-year contract for 6.2 million gallons per day of reclaimed water at no charge. After using the water up to four times, the center discharges it to the Minnesota River.

45
billion gallons
of groundwater saved
due to this project
over 20 years or nearly
10 Olympic-size
swimming pools
per day!



System Change

Motivate consumers to conserve water

Cities, hospitals, prisons and other public water suppliers will assess their water conservation strategies when they file updated water supply plans for 2016–18 with the Minnesota Department of Natural Resources. The goal is to provide sufficient, affordable drinking water while also being prepared for emergencies that disrupt water supplies.

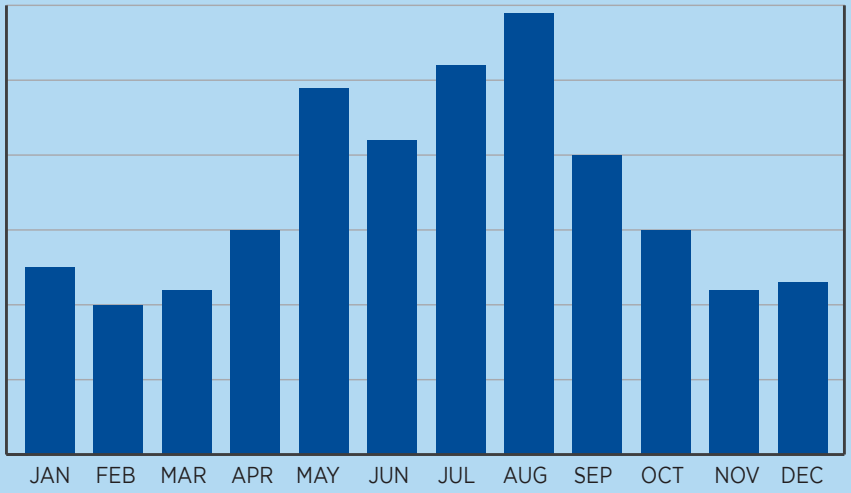
The department must approve plans before suppliers can drill new wells, increase water appropriations or receive drinking water revolving fund loans. As part of the approval process, the department will ask the water suppliers to meet specific conservation objectives, including:

- reduce water loss through leaking pipes to less than 10 percent of water pumped
- decrease residential water use to an average of 75 gallons per day per person
- reduce industrial, commercial and agricultural water use 1.5 percent per year or 15 percent over 10 years
- ease demand on water systems during summer's peak use through conservation
- promote water rates and rate structures that reward conservation, focusing on nonessential uses such as lawn and landscape watering
- establish criteria to track and measure the effect of the water supply plan on the community.

MDH

Demand for municipal water is higher in summer than in winter in Minnesota, due in part to outdoor watering. And the gap is widening: Between 1990 and 1994, summer use was 1.6 times more than winter use, while today, a typical community will use up to 2.3 times more water in summer than in winter. By returning to outdoor watering practices of the 1990s, the Twin Cities metropolitan region may be able to reduce its total water use by more than 15 percent, or 16.8 billion gallons per year.

Seasonal Municipal Water Use in a Typical Twin Cities Community



SOURCE: METROPOLITAN COUNCIL

Manage the cumulative impacts of groundwater withdrawals

The Minnesota Legislature gave the Department of Natural Resources authority to establish groundwater management areas "...to ensure sustainable use of groundwater that protects ecosystems, water quality, and the ability of future generations to meet their own needs" (*Minnesota Statutes*, section 103G.287, subd. 4). In 2014, the department initiated three pilot groundwater management area projects to explore how this new tool can create system change.

The pilot groundwater management area projects (GWMAs) have dramatically increased awareness of groundwater issues among water users in the three areas. In the North and East Metro area, for example, cities are engaging in water supply planning to recognize the limits to growth that groundwater resources represent. In the Straight River and Bonanza Valley areas, discussions are ongoing about the importance of irrigation scheduling and other water conservation techniques to help agricultural producers use water more efficiently.

Sustainable groundwater use:

prevents drawdown of contaminants from the surface or from shallower aquifers into deeper ones

does not interfere with other users

does not affect surface waters

does not harm aquatic ecosystems

meet current and future needs

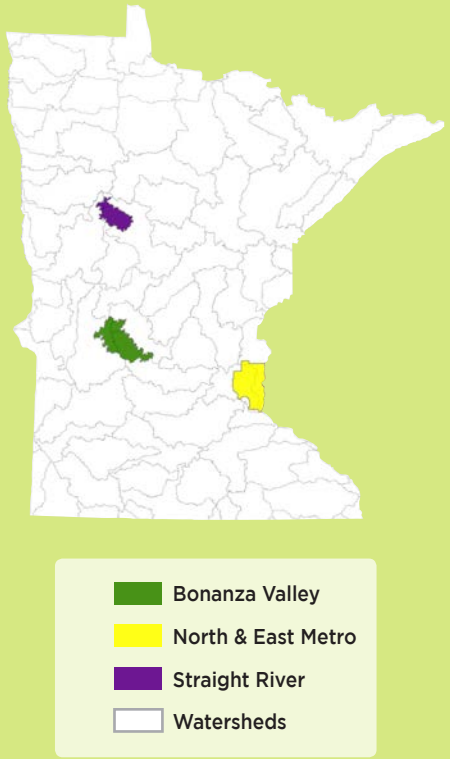
More Study

How can we better monitor and report water use?

To ensure sustainable use of Minnesota's water, we need to understand how much water we have and how much we are using. To measure supply, we have an observation well network that is steadily expanding with a focus on areas with groundwater concerns. Even so, large areas of the state are not adequately monitored. To measure supply, the Minnesota Department of Natural Resources requires appropriation permittees to measure how much water they use. However, it is difficult to obtain accurate information: Only 28 percent of those who report their water use employ an accurate flow-metering device, about 49 percent estimate their use based on time and pumping rate, and 23 percent do not indicate their method or use other methods. More accurate and consistent metering and reporting would allow for evaluation of uses and needs that could inform better water management and conservation.

Groundwater Management Areas

The Minnesota Department of Natural Resources is developing three pilot groundwater management areas plans. These areas have issues related to drinking water supply, irrigation, potential for overpumping, contamination or population growth.



SOURCE: MNDNR

Water and energy systems are interdependent. When we improve one, can we relieve stress on the other?

Water collection, treatment, distribution and heating require a lot of energy, as does wastewater treatment. For local governments this energy represents a huge expenditure. Costs could be reduced through upgrades to the water systems to make them more efficient. For instance, sealing leaks in distribution pipes, using more efficient pumps to collect water, increasing the efficiency of wastewater treatment plants and even generating energy from waste are all ways to reduce energy needs. Can fine-tuning water systems reduce stresses on energy systems?

Water, in turn, is used in energy production. In Minnesota, power plants are the largest user of water, though this is mostly surface water that is returned after use. This use can put stress on aquatic ecosystems during dry periods of the year. Low stream flows combined with high water temperatures can limit the generation capacity of power plants. Could we use electricity more efficiently to reduce water demands?


MINNESOTA RIVER

What should the price of water be in Minnesota?

Current water pricing may not cover the current and future cost of infrastructure for drinking water and wastewater treatment. The U.S. Environmental Protection Agency estimates that meeting Minnesota drinking water infrastructure needs will cost as much as $7.4 billion over the next 20 years. The reported costs to upgrade aging municipal wastewater treatment systems statewide are estimated at $4 billion. Further, 60 percent of necessary upgrades are at facilities located in Greater Minnesota. Because the costs of these upgrades come in municipal water bills, affordability is a critical barrier. With treated wastewater flowing into lakes and streams and thus broadly impacting water quality statewide, the modernization of wastewater infrastructure is crucial to future water quality in the state.

60 PERCENT
of the necessary wastewater treatment upgrades are at facilities located in Greater Minnesota.


MPCA

Can we develop crops that are better adapted to drought?

Changes in climate affect rainfall variability during the growing season. Drought-tolerant crops not only need less water, they also can boost water quality by providing ground cover and reducing erosion and the transport of some contaminants. Research and development of drought-tolerant hybrids should investigate how the amount and intensity of precipitation affects nutrient uptake and mobility.

Is the amount of groundwater we discharge as treated wastewater sustainable?

Minnesota exports 99 billion gallons of groundwater each year (the equivalent of 150,000 Olympic-size swimming pools!) by pumping it to municipal users. These users send it to wastewater treatment facilities where it is discharged into rivers and lakes and ultimately ends up outside state borders. As groundwater use increased in the past decade, so did the volume of discharge. We don't have a comprehensive understanding of the effect of this increased volume on downstream waterways and habitat. We do know, however, that if the rate of withdrawal exceeds the rate at which the aquifer is recharged by precipitation and inflow, withdrawal can draw down aquifers.

SUCCESS STORY

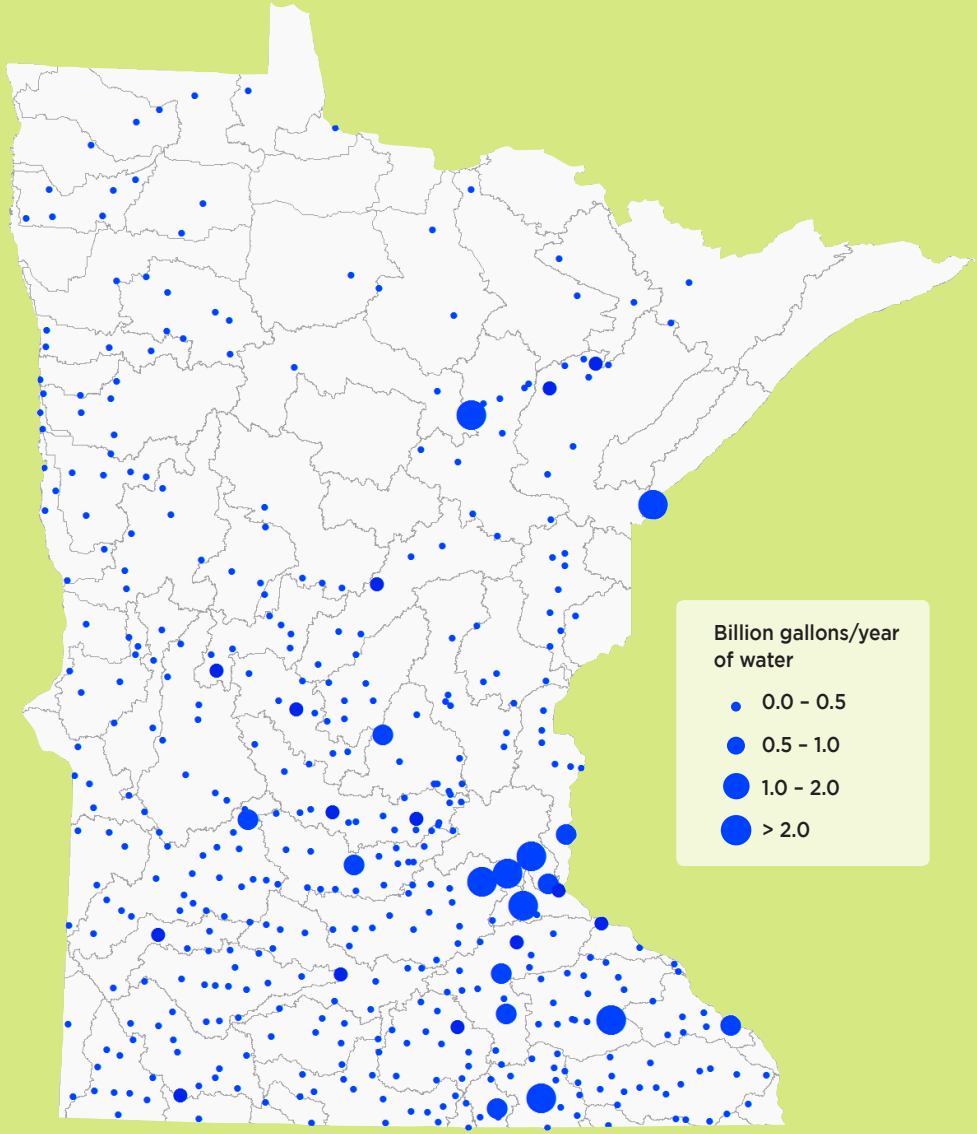
Water Recycling

The City of East Bethel lacks a large river system into which it can discharge wastewater treatment plant effluent. After being asked to provide wastewater treatment services to the community, Metropolitan Council Environmental Services designed and built a water reclamation plant that sends treated water into the groundwater system through land application. The system also makes it possible to use effluent to irrigate golf courses and other grassy areas. Both of these allow groundwater withdrawn for human use to remain in the watershed.

LAKE PEPIN

Discharge of Groundwater Into Surface Water

Pumped groundwater is used once, treated at wastewater facilities, and then it is discharged into surface waters (2009 - 2011).



SOURCE: MPCA

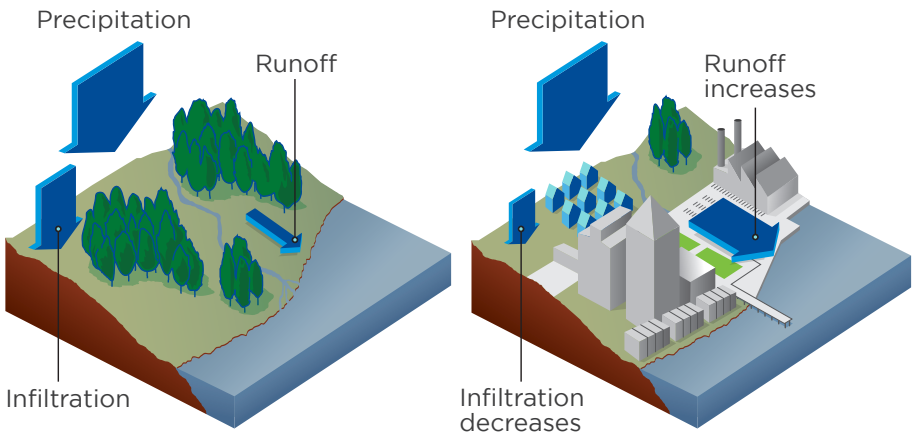
Goal #2: Manage Runoff in the Built Environment

Manage our built environment to protect water

When we build roads, sidewalks, buildings, parking lots and other impervious surfaces, we change the flow of water. When we convert pervious soils stabilized by plant roots into impervious surfaces, we change how water runs off the landscape. These changes include an increase in the speed and volume at which runoff enters storm sewer systems, lakes, wetlands and streams, and a decrease in the amount of water that goes into the ground. Surface runoff from the built environment can contain sediment, oil, fertilizer, pesticides, grass clippings, leaves, litter, pet waste, organic compounds, heavy metals and chlorides.

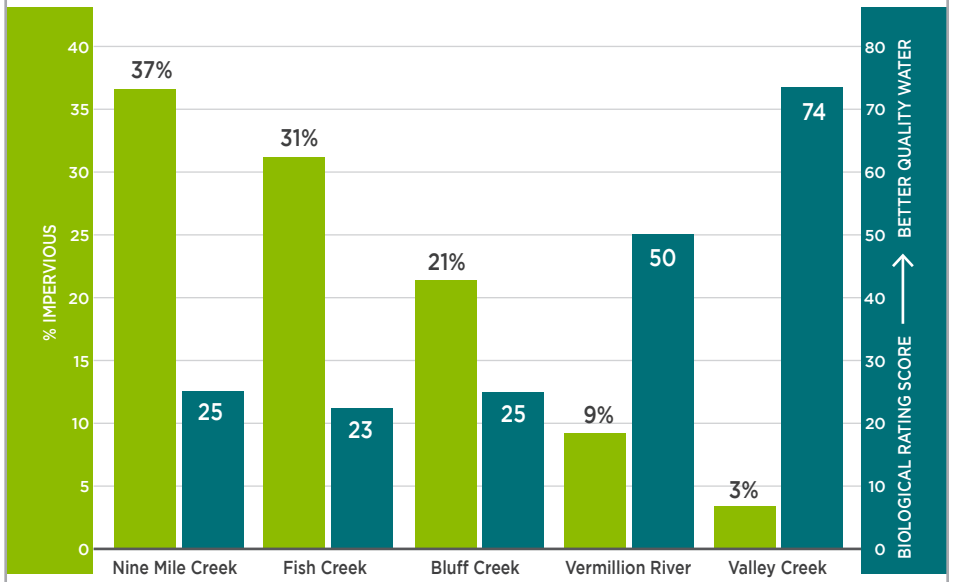
Suspended sediments, algae, bacteria and other pollutants can make lakes and rivers dangerous and unappealing for swimming and boating. Aquatic life in streams and lakes can be affected by small increases in pollutants such as metals or chloride, temperature, or altered hydrology. Without strong biological health, water bodies are unlikely to sustain healthy fish communities.

Conventionally built environments increase runoff and reduce the amount of precipitation that soaks into the soil.



Impact on Aquatic Ecosystems

Studies from 2004 to 2011 show that higher impervious cover is associated with degraded ecosystems.

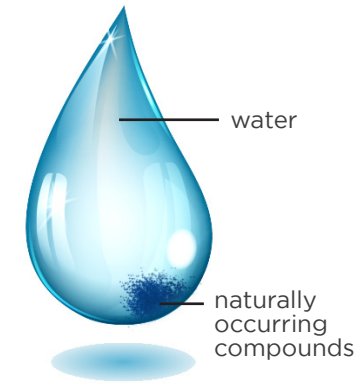


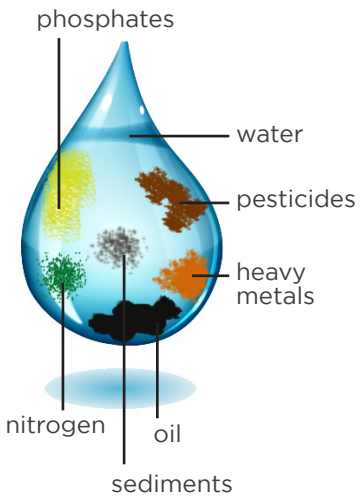
SOURCE: METROPOLITAN COUNCIL

Designing the built environment to mimic natural hydrology

One approach to combat the water-polluting effects of urbanization is to hold water on the landscape after rain rather than allowing it to rapidly run into storm sewers, lakes and rivers. This approach mimics natural hydrology by increasing infiltration, decreasing runoff and increasing water storage — which together reduce flooding while giving pollutants a chance to filter out before they enter lakes and streams. "Green infrastructure" such as rain gardens and pervious parking lots can complement traditional infrastructure and help built environments behave more like a natural landscape. It can be implemented at a scale as small as your back yard or as big as city street reconstructions or the development of large subdivisions.

A Predevelopment Raindrop Compared With a Drop of Water With Contaminants From Runoff





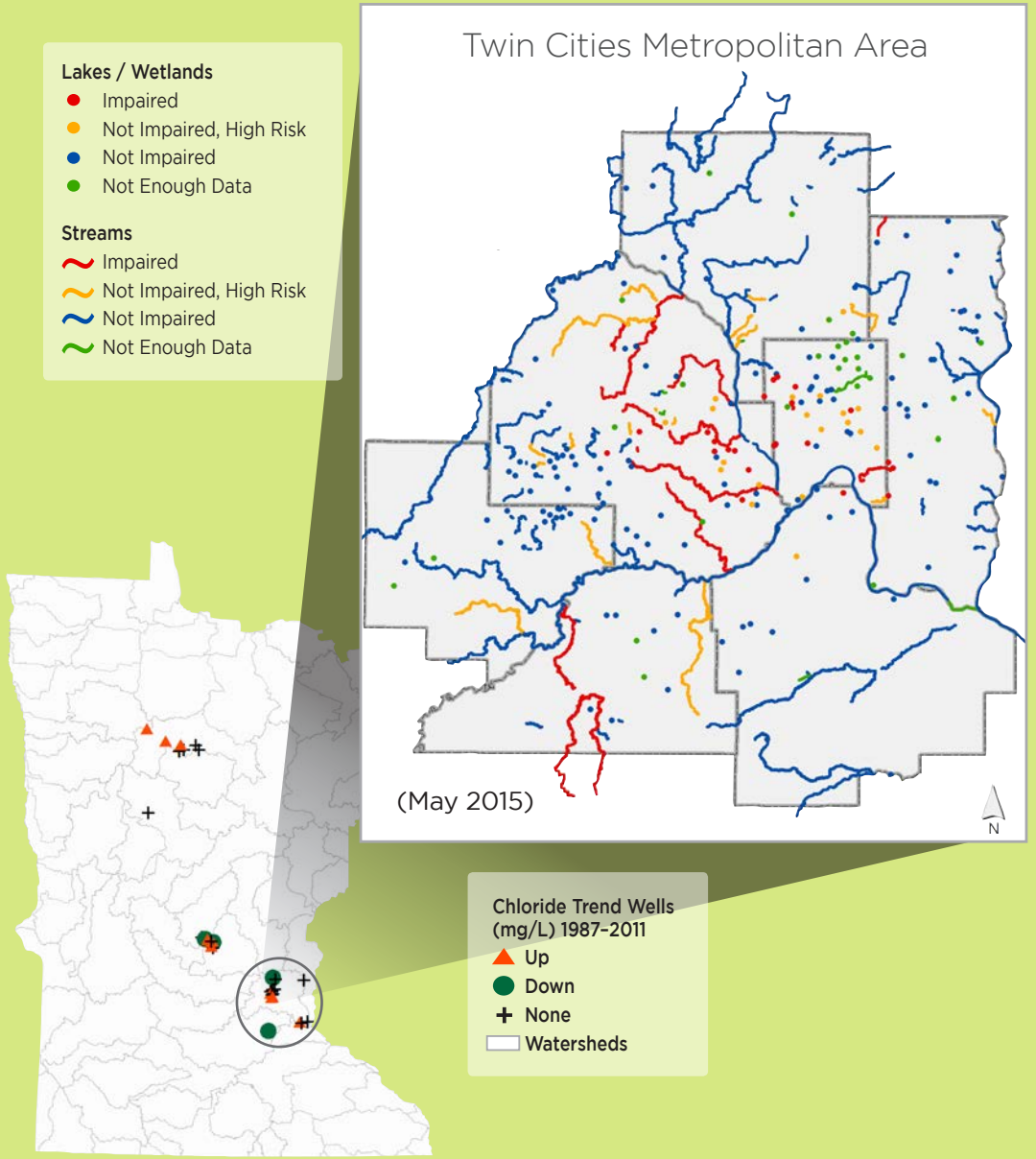
Chloride

An emerging issue in management of runoff in the built environment is chloride. Chloride is a salt that is a key ingredient in winter deicing chemicals and water softeners. Chloride from winter deicing chemicals in urban runoff is an increasing concern for water quality, particularly because removal from water systems is prohibitively expensive. At high concentrations, chloride can harm fish and plant life. Chloride concentrations have increased in about one-third of the wells sampled in the Twin Cities metropolitan area. Water softener brine discharges to municipal wastewater treatment plants also contribute chloride to water across the state.

Some 349,000 tons of chloride in the form of winter deicing chemicals are applied in the Twin Cities metropolitan area each year.

Chloride in Our Waters

Chloride concentrations in wells, lakes, streams and wetlands are trending up in many parts of the state.



SOURCE: MPCA

Voluntary Solution

Control and filter runoff with green infrastructure

Runoff with contaminants from roads, sidewalks, buildings, parking lots, roofs and other impervious surfaces can feed into lakes, streams and groundwater. To hold the water on the land and filter out pollutants, we can alter the landscape to mimic natural hydrology with green infrastructure. Elements of green infrastructure include trees, pervious pavement, swales, rain gardens, infiltration strips, green street design and green roofs. In addition to improving water quality, these elements offer other valuable benefits, including improving air quality, keeping cities cool, adding wildlife habitat, and improving aesthetics and property values. Scoring criteria for the Clean Water Project Priority List, which provides ranking for grants and low-interest loans to communities, was recently amended to prioritize green infrastructure projects.

Runoff can carry contaminants to surface water and groundwater.

SUCCESS STORY

Owatonna Flooding

Between 2000 and 2007, Owatonna experienced four extreme rain events that caused more than $10 million in damages. The problem of downtown flash flooding, including flooding of the city library, was traced to an increase in impervious surfaces as homes were replaced by parking lots. To mitigate the problem, the city installed rainwater harvesting infrastructure, rain gardens and porous alleys. The porous alley not only protected the library from flooding, but also reduced the amount of pollution washing into area waterways.

Regulatory Solution

Require stormwater capture at construction sites

Minnesota regulates the creation of impervious surfaces through permits to ensure soil is protected from erosion when an area greater than 1 acre is developed. Developers need to have adequate plans for minimizing stormwater pollution during construction and have inspectors ensure stormwater practices remain functional. New to these permits is the requirement to capture the first inch of water that lands on a site during a storm. Except for special circumstances, developers must use infiltration, a form of green infrastructure, to capture the water.

Minnesota requires cities, townships, public colleges and watershed districts that are either part of an urbanized area or meet population thresholds to obtain a permit to discharge stormwater into sewers or surface water. Municipal stormwater permit requirements for construction include a strong preference for green infrastructure to manage stormwater.

System Change

Institute Minimal Impact Design Standards

Minimal Impact Design Standards are voluntary standards developed by the Minnesota Pollution Control Agency at the direction of the Minnesota Legislature and stakeholders that enable and promote the use of designs that manage runoff and stormwater above and beyond permit requirements. The design standards package, which is being used by communities and individuals around the state, includes four major elements:

- stormwater volume performance goals for new development, redevelopment and road projects
- a calculator to assess potential impacts of project
- design specifications for green infrastructure
- an ordinance guidance package.

Vegetation slows the flow of water and helps filter contaminants.


LINDSTRÖM

SUCCESS STORY

Lindström Green Infrastructure

Since 2011, the city of Lindström has installed 35 rain gardens, two sand filters, four vegetated swales, one gully stabilization, one shoreline restoration and one permeable parking lot. These projects will annually keep some 24,000 pounds of sediment and nearly 30 pounds of phosphorus out of nearby lakes.

MINIMAL IMPACT DESIGN STANDARDS PROJECTS TO DATE COVER

300,160 ACRES.

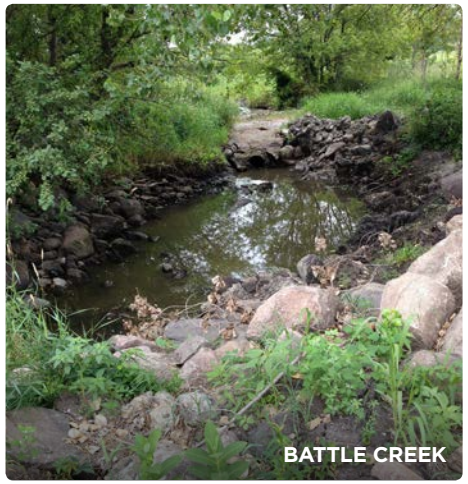
More Study

Can we minimize or reverse past water quality degradation due to historic urbanization?

We need to assess the performance of green infrastructure to determine where it is having the biggest impact. We can do so by monitoring the flow, chemistry, biology and habitats, before and after green infrastructure is deployed, of:

- relatively pristine streams and lakes with encroaching development
- streams in urban watersheds on the cusp of not being able to support aquatic life

We can use the monitoring results to assess the effectiveness and weigh the costs and benefits of best management practices.


BATTLE CREEK

Green infrastructure is an approach to water management that protects, restores or mimics the natural water cycle.


BUILDINGS

HARDSCAPE

Green Infrastructure

can be used across our communities


LANDSCAPE


SURFACE WATER

Voluntary Solution

Provide stable funding for smart salting training programs

The Minnesota Pollution Control Agency provides smart salting training to local governments and private applicators to teach winter maintenance professionals how to apply deicing chemicals in a way that creates safe walking and driving conditions while minimizing water contamination. However this program has limited federal funds. Stable funding and new delivery models are needed to maintain and expand training opportunities. Training for Minnesota Department of Transportation maintenance workers is provided annually by the department, and local agencies can request training through the Minnesota Local Technical Assistance Program.

SUCCESS STORY

Joe's Lawn & Snow

In Minneapolis, Joes Lawn & Snow treats sidewalks and parking lots with deicing chemicals. Before attending the Minnesota Pollution Control Agency's smart salting training class, Joe's employees relied on application rates listed on deicers and their own best judgment to determine how much material to apply. After taking the course, the employees reduced salt use by about 50 percent without reducing their level of service.

TWIN CITIES METRO

Department of Transportation Technology Deployment

228,946 tons
(AVERAGE OF PAST 5 SEASONS)

COST BASED ON AVERAGE CURRENT PRICE
$17.2 million

POTENTIAL SAVINGS WITH THE MAINTENANCE DECISION SUPPORT SYSTEM
$5.2 million
(approximately 30%) per year

Regulatory Solution

Reduce liability for applicators who attend training on best management practices

Private applicators of winter deicing chemicals assume risk of liability should someone slip and get hurt due to inadequate treatment. To provide an incentive to balance safety and environmental concerns, the state could limit liability for private applicators and business owners who contract with them if the private applicator goes through smart salting training and is certified.

SUCCESS STORY

Limited Liability

New Hampshire passed a law in 2013 to limit the liability of business owners and private applicators who contract or conduct snowplowing or deicing if the applicator is certified through the University of New Hampshire's Green SnowPro program. Since then, winter deicing chemical use has decreased 20 percent and water quality has improved.

SUCCESS STORY

Waconia Winter Deicing

The city of Waconia's Public Services Department applies deicing materials on street center lanes, concrete sidewalks and trails. By switching from hand-applied and truck-applied chloride products to liquid applications and making calibration and equipment changes, staff reduced the rate of applied deicing salt by 70 percent.

SUCCESS STORY

Prior Lake Winter Deicing

Over seven years, Prior Lake upgraded its deicing fleet with controllers and new sanders that apply pre-wet material at more efficient rates than dry application. Average application rates plummeted from 500 pounds of salt per lane-mile in 2005 to 200–250 pounds per lane-mile of pre-wet salt in 2010. Overall road salt use dropped 42 percent from 2005 to 2010 even with a 7 percent increase in mileage.

System Change

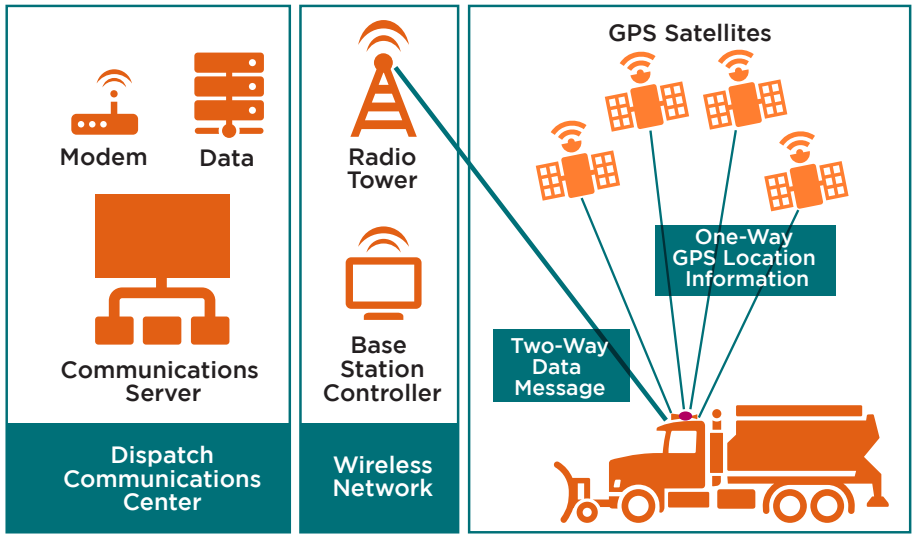
Provide funding to deploy smart technology

Historically, deicing chemical applicators decided how much chemical to apply based on experience and route details. Today, technologies are available that reduce the volume of chemicals needed. Some of these technologies change application methods, while others are based on integrating site-specific data. Expansion of liquid deciers has been the most widespread result of these efforts. The Minnesota Department of Transportation deploys two new software tools, the Maintenance Decision Support System and Automated Vehicle Location, which use weather forecasts, current and forecast pavement conditions, and knowledge of route-specific equipment and materials to make situation-specific treatment recommendations and provide them to operators and field supervisors. These tools remove uncertainty that can lead applicators to over-apply chemicals. They also can save money by reducing extra snowplow shifts and overtime hours, decreasing the number of truck miles, limiting liability by documenting how much salt is placed on a road and reducing the cost of deicing materials.

Local governments are limited by funds in their ability to deploy these technologies. Given the eventual payback from savings on overtime expenses, fuel and truck maintenance, and reduced chemical use, these technologies could be financed with revolving loan funds or a program in which users pay for the tools from savings that accrue.

TWIN CITIES METRO

Maintenance Decision Support System and Automated Vehicle Location



More Study

How can we better address public expectations and engagement in deicing chemical application?

Traditional education campaigns are important tools for raising awareness about how deicing chemicals impair lakes, rivers and groundwater. However, changing attitudes about deicing chemicals will also require a planning process that engages citizens, watershed organizations, lake associations, neighborhood groups and local governments. The planning process is an opportunity for public discourse on the trade-offs among cost, environmental concerns, and acceptable winter conditions for driving and walking. Resulting snow management plans could provide clear guidance and standards for practices such as:

- snow removal and disposal
- deicing chemical storage and application
- winter construction control
- pollution prevention.

Data shows chloride levels continue to increase in surface and groundwater across the state. In the Twin Cities metropolitan area, thirty-nine waterbodies exceed the water quality standard for chloride and many more are unknown.

Goal #3: Increase Living Cover

Increase and maintain living cover across watersheds

An important part of comprehensive watershed planning is to strategically increase and maintain diverse living plant cover. Living cover helps restore aspects of natural hydrology by holding water on the landscape, filtering contaminants and allowing water to recharge aquifers while reducing runoff. Living cover over the recharge area of wells and aquifers can filter out contaminants and protect drinking water sources. Similarly, living cover can help filter and reduce the volume of runoff to lakes and streams, preventing harm to ecosystems and places we value for recreation or habitat. In Goal #2 we focus on the built environment, while this section focuses on other lands.

Agriculture is central to our economy and food security, but we need to reduce water quality threats through strategic land use practices, such as prioritizing the most productive lands for annual row crops while converting highly erodible and marginal production lands to living cover. Global market forces and federal and state policy have changed agriculture in ways that contribute to water contamination — for example, increasing row crop production, changing tillage, increasing miles of agricultural drain tile, and converting grasslands and forests to farmland. We have not yet offset these impacts with a corresponding change in land use to protect soil and water. By putting all of the pieces of the watershed puzzle together, we can ensure that every Minnesotan has access to clean water to drink, to play in and to fish as well as to support a vibrant economy.

Progression of Changes in Blue Earth County

1937
This 400-acre farm is on flat land with poorly drained soils. Diverse crops include oats, alfalfa, pasture, wild hay, barley and corn. Note depressional sloughs or "potholes" dotting the landscape.

1948
The tile system was installed in 1948. It was estimated that 38,000 feet of tile were laid on this 400-acre farm.

1952
By 1952 soybeans and corn were planted on a larger portion of the farm along with pasture, peas, winter wheat, alfalfa, oats and flax.

2015
Aerial photos of the farm from the 1960s to present show the farm predominantly in corn and soybean rotations.

Before being converted to farmland, the landscape included a range of natural features, such as wetlands and prairie. Technology has allowed us to boost agricultural efficiency and productivity to enhance food security, but also has made the landscape more homogeneous, with fewer acres of small grains and perennials such as hay.

CREDIT: DR. SHAWN P. SCHOTTLER

Living cover includes:

Perennial crops: Perennial grasses, hay and pasture anchor the soil, build organic matter, and increase the soil's ability to hold water and nutrients.

Cover crops: Grasses, small grains, legumes and winter annuals provide cover before the primary crop establishes and after it is harvested, reducing runoff, erosion and nitrate leaching.

Prairie and grasses: Grasses and prairie plants have extensive root systems that hold soil in place. Grass or prairie buffers can be added in fields, on field edges or as grassed waterways.

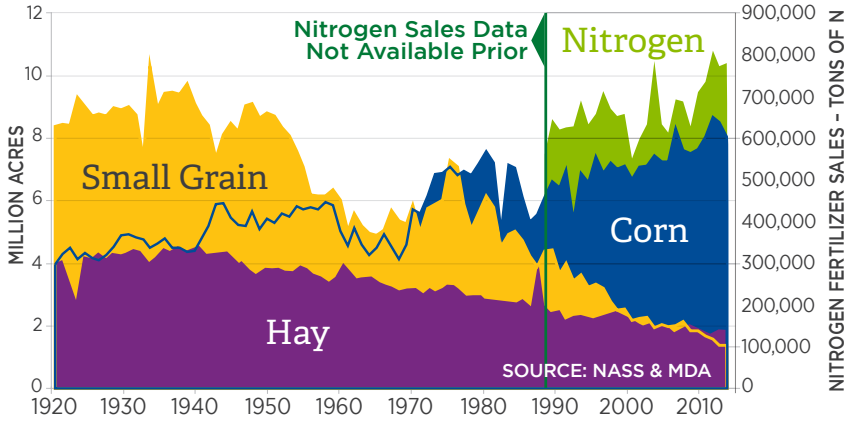
Wetlands: Natural and constructed wetlands prevent erosion and filter water, absorbing excess nutrients before they enter lakes and streams.

Forests: Forests filter water and maintain deep root systems that stabilize soil and build organic matter.

No till/minimum till: After harvest, plant residue can be left in place to protect soils from erosion before crops establish the next spring.

Long-Term Trends for Corn, Hay and Small Grain: 1921 to 2014

As Minnesota's crop mix shifted toward corn, nitrogen fertilizer sales rose and threats to water quality increased.

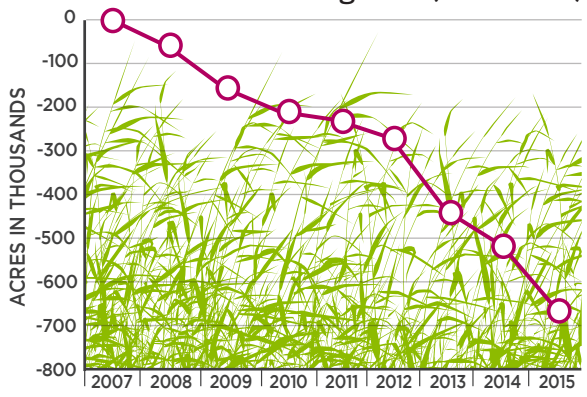


Conversion of forested land in the Central Sand Plains is removing living cover from an area vulnerable to groundwater contamination. Some of the land is being converted to agriculture. In these sandy soils, tillage and nitrogen fertilizer from row cropping can result in nitrate leaching into groundwater and discharging into surface waters. Some communities in this area have experienced previous nitrate contamination that required building expensive treatment facilities, blending in low nitrate water, or drilling new wells to meet the safe drinking water standard.

Loss of Acres in Conservation Reserve Programs (Statewide)

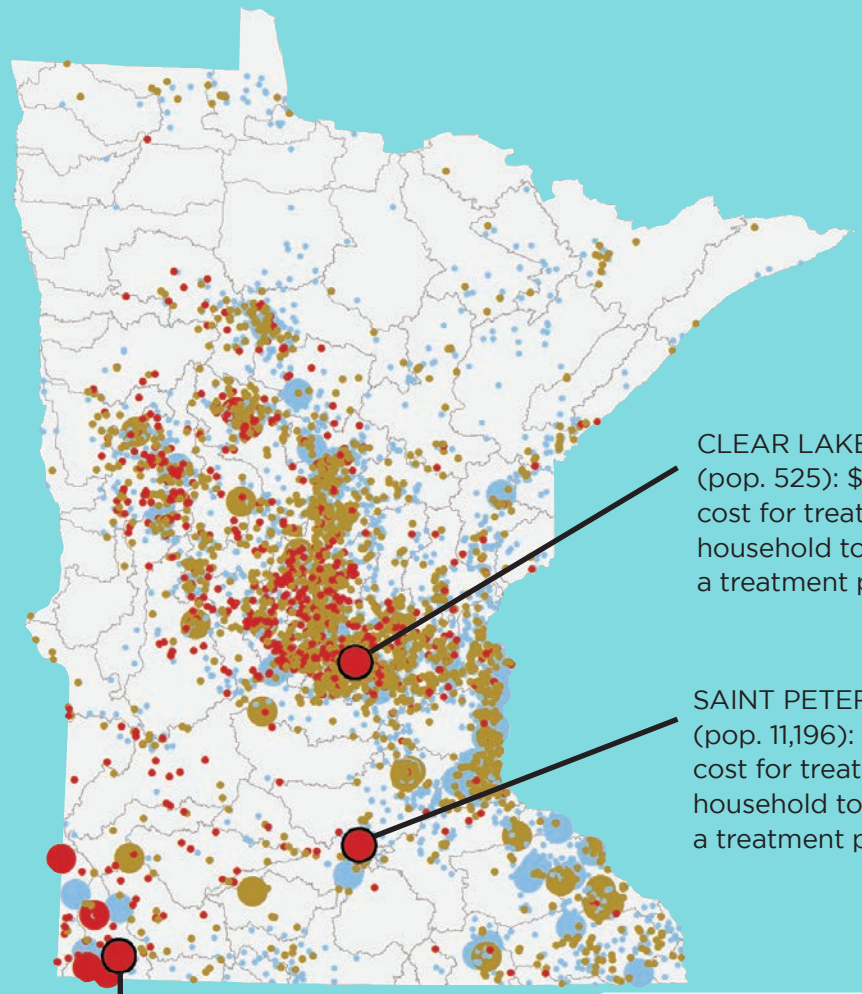
Between 2015 and 2018, contracts for nearly 495,000 acres of Conservation Reserve Program (CRP) land will expire if landowners do not re-enroll.

SOURCE: MNDNR



Maximum Nitrate–Nitrogen Concentrations in Public and Domestic Wells

The map shows three categories of contamination in mg/L: showing human influence (3–5), of concern to state agencies (5–10), and above the federal safe drinking water standard (>10). (1990–2015)



CLEAR LAKE
(pop. 525): $7,600 cost for treatment per household to replace a treatment plant

SAINT PETER
(pop. 11,196): $1,600 cost for treatment per household to build a treatment plant

ADRIAN
(pop. 1,209): $3,300 cost for treatment per household to seal wells and build a treatment plant

Domestic Wells	Public Supply Wells
>10 (mg/L)	>10 (mg/L)
5 – 10	5 – 10
3 – 5	3 – 5

SOURCE: MDH & MGS

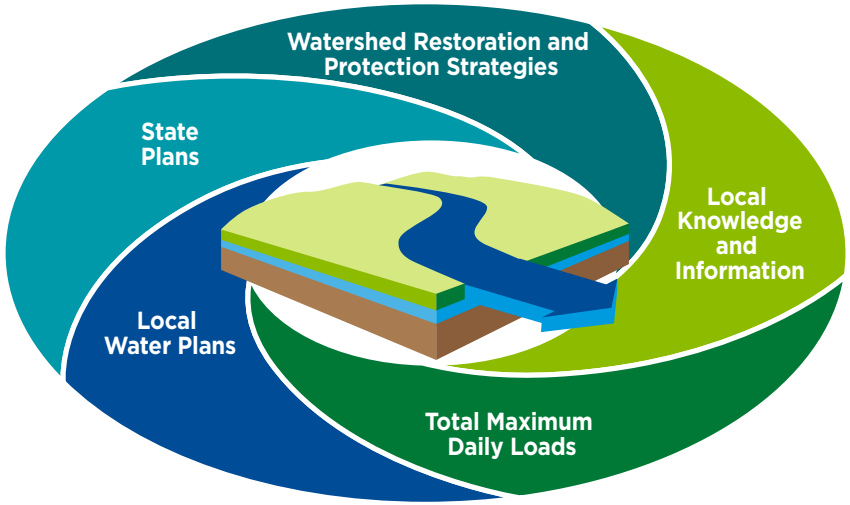
Voluntary Solutions

Manage water using One Watershed One Plan

Minnesota has a long history of water management by local government, including the seven-county Twin Cities metropolitan area and the Red River Basin. Building on this history, the state is now moving toward managing water based on watersheds rather than political boundaries. Based on a legislative initiative led by local governments and the Board of Soil and Water Resources, "One Watershed One Plan" will result in water management plans that are data driven and provide for public discussion of trade-offs and shared goals. Plans generated through the One Watershed One Plan approach identify local water quality targets, pollutant reduction goals for downstream waters and strategies to meet the goals, such as increasing living cover to filter runoff and prevent erosion, and restoring forests in the watershed. Actions in the plans are measurable and evaluated against 10-year milestones. The plans use existing management structures and increase collaboration and cooperation across political boundaries.

56% OF MINNESOTA HARVESTED ACRES WERE RENTED IN 2012

One Watershed One Plan




LAKE COMO

Provide cost sharing for practices that promote living cover

Many factors can make it hard to increase living cover on agricultural lands. Some lands are used by renters, who typically require a shorter payback period than that provided by investments in living cover. And historically, structural (engineered) conservation practices such as installing water and sediment control basins, terraces, and diversions have been eligible for Clean Water Funds, state cost-share funds or other financial support, while nonstructural conservation practices, such as planting cover crops, using conservation tillage and rotating crops, have not been eligible or have not been prioritized. Thanks to recent changes to *Minnesota Statutes,* chapter 103A, soil and water conservation districts may now help pay for nonstructural land management practices that increase living cover to control erosion or improve water quality.

Best management practices (BMPs) are agricultural practices that protect the environment. BMPs recommended for Minnesota farmers include conservation practices developed and approved by the U.S. Department of Agriculture's Natural Resources Conservation Service to prevent soil erosion and nutrient losses and by the University of Minnesota to improve efficiency of nitrogen fertilizer applications. BMPs are designed to be economically viable and in many cases save farmers money. Implementation costs for many BMPs are eligible for federal and state cost-share funding and loan programs.

BMPs are discussed in detail in "The Agricultural BMP Handbook for Minnesota" (see Appendix), which is continually updated with new knowledge and research. They are vital for protecting Minnesota's water resources; however, in some vulnerable areas, adoption of BMPs will not provide sufficient improvement to meet water quality goals without strategic use of living cover. Additionally, living cover provides the greatest opportunity to achieve large-scale water quality improvement.

Regulatory Solutions

Implement Minnesota's buffer initiative

Minnesota's 2015 buffer law designates an estimated 110,000 acres of land to living cover. These "buffer strips" along rivers, streams and ditches will filter out phosphorus, nitrogen and sediment, protecting water quality. They will also help us make progress toward our headwaters nutrient reduction goals. Because surface waters connect to lakes and groundwater, the benefits will be broad and include protecting drinking water, habitat and recreation opportunities. The law will require perennial vegetation, such as grasses, on up to 50 feet along public waters and 16.5 feet along public ditches. The next step is implementation, which will be led by local soil and water conservation districts with support from state agencies.

Harmful Blooms

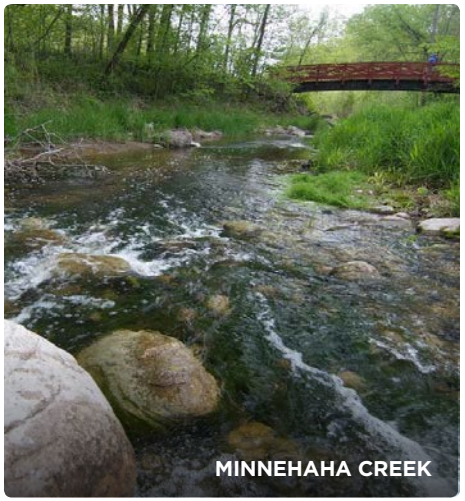
Cyanobacteria, also known as blue-green algae, can proliferate in lakes when exposed to heat and excess phosphorus — a nutrient common in agricultural runoff. They produce toxins that can sicken people, and they can kill pets, livestock and wildlife.

KANDIYOHI COUNTY

Models show that additional living cover will be needed to meet Mississippi River nitrogen reduction milestones aimed at reducing harm to the Gulf of Mexico as nutrients carried downstream spur algae growth and deplete oxygen needed by marine life. To reduce nitrogen approximately 20 percent by 2025, we'll need more than 1 million more acres of cover crops in concert with several other conservation land use practices.

Use living cover around wellheads to prevent groundwater contamination

It is critical to protect the area around public and private wells (the wellhead) from land use and runoff that pollute drinking water. The wellhead area can range from several acres to hundreds of acres, depending on soils, geology and hydrology. Of particular concern, in some parts of Minnesota, is the increasing contamination from nitrate, largely coming from row crop agriculture. The wellhead could be protected by changes in producer practices that reduce nitrogen fertilizer use and maintain or establish living cover to filter runoff before it reaches well water. Minnesota's Wellhead Protection Rule requires public water suppliers to prepare wellhead protection plans. On high-risk lands, protection plans may include long-term conservation and easement programs, such as Reinvest in Minnesota and the Conservation Reserve Program, that pay farmers to establish living cover. For private wells, landowners are responsible for monitoring and remediating their drinking water.



MINNEHAHA CREEK

SUCCESS STORY

Wellhead Protection

Contaminants easily move from the land surface into shallow sand and gravel aquifers that provide drinking water to Perham, a hub for business and agriculture in Otter Tail County. In the late 1990s, city wells approached the safe drinking water threshold for nitrate, so the city began to work on wellhead protection to reduce nitrate contamination. Through citizen engagement and education, the community built momentum in 2005 to convert 285 acres of row crop agriculture on the wellhead area to other uses with lower water impacts. This change reduced nitrate levels to meet drinking water standards.

System Change

Institute a fertilizer surcharge to provide compensation for drinking water treatment where contamination has occurred

While strategic use of living cover in watershed management can reduce groundwater contamination, some wells are already contaminated. Closing wells and treating contaminated water supplies is extremely expensive, and the individuals and communities paying the price often are not those whose activities led to that contamination. A nitrate compensation fund could be developed by the Minnesota Department of Agriculture to provide compensation to parties affected by nonpoint sources of nitrate. The fund could come from a surcharge on sources of nitrate in groundwater, including commercial nitrogen fertilizer. Funds could be provided for drinking water treatment systems or alternative sources to ensure that nitrate is below the drinking water standard. This surcharge strategy addresses past damages, and should be paired with preventive land use management to protect our drinking water supplies from future contamination.

The Des Moines, Iowa, Dilemma

Nitrate contamination of Des Moines' drinking water sources — the Des Moines and Raccoon rivers — means the city needs expensive infrastructure to make the water safe. Seeking compensation for treatment costs, the Des Moines Water Works sued counties that sponsor drainage districts contributing contaminated surface waters to the city's drinking water supply. Agriculture stormwater runoff is exempt from the federal Clean Water Act. However, the Des Moines Water Works alleges that drainage ditch discharge is a point source rather than runoff and so must comply with the Clean Water Act and the National Pollution Discharge Elimination System.

In the Midwest, soils converted from natural to agricultural systems have

lost 30–50% of their original organic carbon.

Enhance existing markets for perennial-fed beef and dairy products and bioenergy from perennial crops

Over the past few decades, market forces and federal and state policies created strong incentives for Minnesota farmers to grow row crops — particularly corn and soybeans. The resulting loss of perennial crops, conservation lands and small grains reduced the ability of agricultural lands to keep contaminants out of waterways while increasing the need for fertilizer and drainage systems. To encourage the addition of substantial acreages of perennials and other living cover, public and private partnerships could create new or enhance existing markets for these products by differentiating them as environmentally responsible. New sections of *Minnesota Statutes,* chapter 41A, passed in 2015, established incentives for producing advanced biofuels, renewable chemicals and biomass thermal energy from perennial or cover crops. Promoting Minnesota as a source of grass-fed beef and dairy could also drive land use toward perennial crops.

Factors Driving Crop Choices

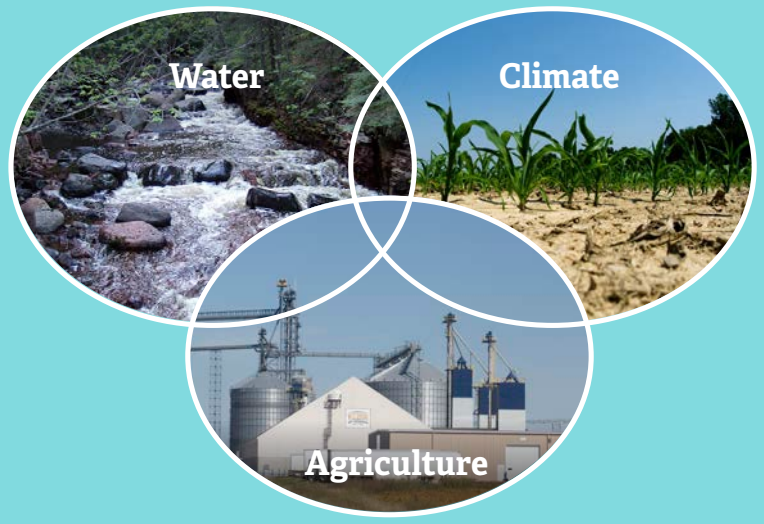
Enhance Minnesota's certification system for responsibly produced agricultural products

Many consumers and companies want to know that the products they purchase are produced sustainably and do not degrade water quality. Likewise, producers who choose best management practices, especially if those practices come at a cost, want their products valued more highly for their environmental responsibility. Given the information, many consumers and companies choose to pay more for U.S. Department of Agriculture organic–certified farm products and Forest Stewardship Council–certified wood products. Similarly, the new Minnesota Agricultural Water Quality Certification Program certifies farmers when every field and cropping system on a farm attains an environmental standard determined by a water quality risk assessment. Certified producers are considered to be in compliance with water quality regulations during the period of certification, and receive priority for technical and financial assistance. By establishing industry standards for agricultural practices and providing objective third-party validation, this program creates a new option for consumers. Now, consumers can choose products produced with practices that protect water quality, creating market forces that drive adoption of living cover and other best management practices that protect water quality.


FILLMORE COUNTY

PLAINVIEW

Interconnected: Agriculture, Water Quality and Climate Change



Anticipated increases in extreme heat, heavy downpours and flooding in coming years threaten infrastructure, health, agriculture, forestry, air and water quality, and more. In particular, agriculture could experience more crop failures, shifts in geographic range of crops, reduced yields and other potential impacts. But agriculture is not only facing the consequences of a changing climate; as the third biggest emitter of greenhouse gases, farming contributes to the problem as well. Some of the main sources of agricultural greenhouse gas emissions — fertilizer application and the loss of organic carbon through tillage and erosion — also contribute to water degradation. The use of living cover to hold carbon in the soil and to take up excess nutrients would not only reduce greenhouse gas emissions, but also improve water quality, air quality and crop productivity.

Nitrogen fertilizer applications release nitrous oxide into the atmosphere, a greenhouse gas with 300 times the atmospheric warming potential of carbon dioxide.


RICE COUNTY

More Study

What percent of Minnesota farmlands leave crop residue on the ground, and how does this affect erosion?

We need data on adoption of practices that protect water quality so we can track trends, prioritize government support, and measure progress toward goals and requirements. One practice of interest is minimum tillage, in which crop residue is left on the field. While crop residue is not living cover, it does help protect soils from erosion. The 2015 Clean Water Fund appropriation includes funding for the Board of Water and Soil Resources to collect data on tillage and erosion; estimate county, watershed and statewide soil erosion caused by water and wind; and track adoption of minimum-till or no-till farming. Surveys will allows us to track the status and progress of tillage practices and erosion trends.

How can we quantify soil conservation benefits to agriculture producers?

Farmers weigh the cost of land management practices, including conservation practices, against their bottom line. Practices that reduce erosion and improve soil health, such as those that increase living cover, can provide yield and financial benefits. However, farmers may not see the benefits for years. This lagging benefit is difficult to quantify, especially for rented lands. A comprehensive cost-benefit analysis of soil conservation practices such as cover cropping could help farmers factor into their bottom line benefits such as increased yield, increased water holding capacity, reduced erosion, increased nutrient cycling and retention, increased soil organic matter, and resilience to drought.

Farmers rely on many resources for crop advice: soil and water conservation districts, University of Minnesota Extension and the local Natural Resources Conservation Service. However, more and more often they are turning to private crop consultants. Crop consultants sell products and advise farmers on business decisions about soil fertility, seed selection, pest and weed management, and new technologies. **The state and other entities that promote conservation practices need to work with crop consultants to help them incorporate conservation practices into business decisions.**

SUCCESS STORY

Green Partnership

The Forever Green Initiative, led by the University of Minnesota, is an effort to selectively add winter-annual and perennial crops to our agricultural landscapes and create new, more diverse crop production systems. Scientists working with the Forever Green Initiative partner with businesses to explore end uses for new crops. Business partners include companies such as Estée Lauder, Patagonia and General Mills. The initiative promotes new, high-value commodity crops to benefit the environment, improve productivity and increase profitability.


MINNAQUA

ABOUT

75%

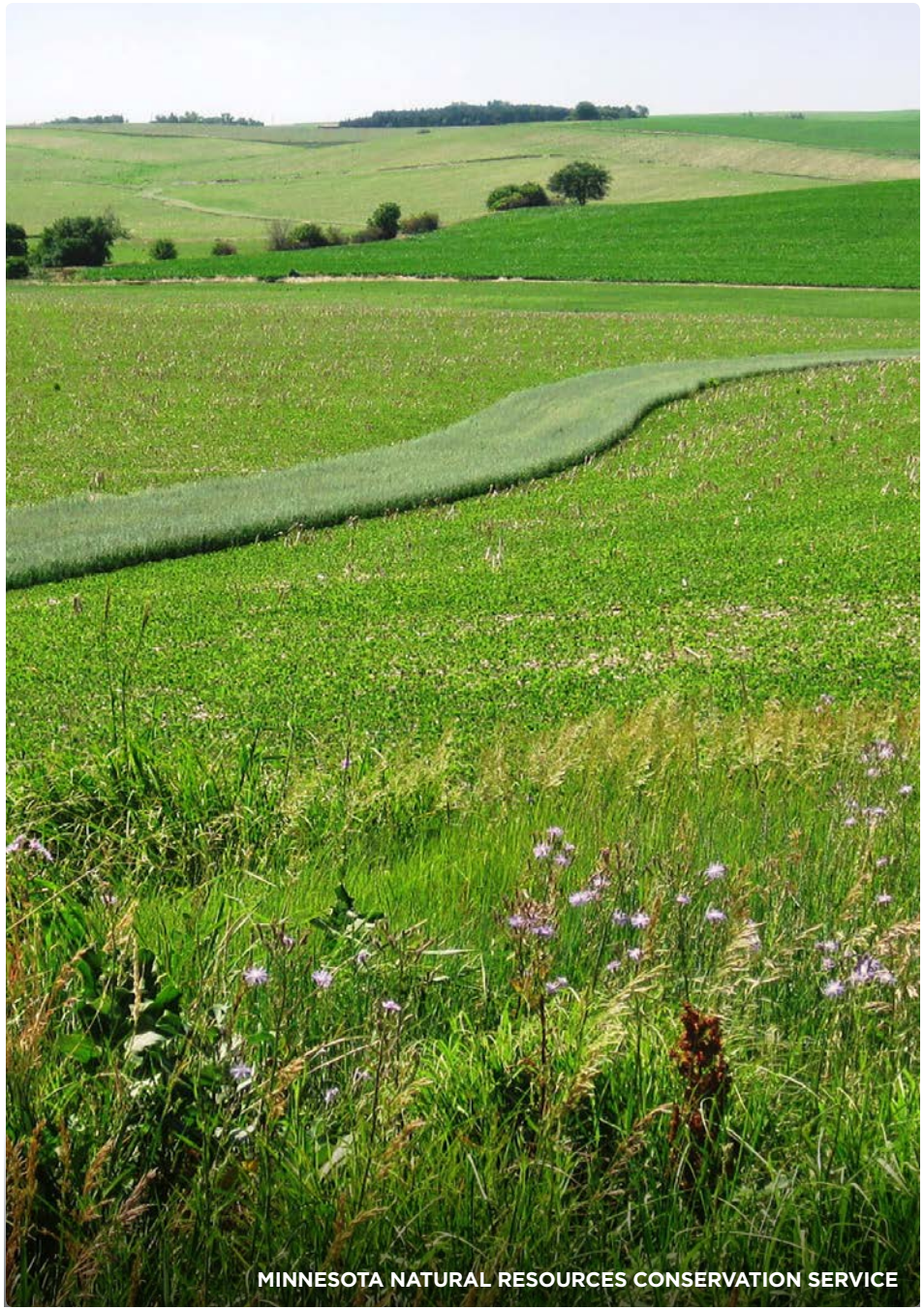
OF CROPLAND IN MINNESOTA IS CORN AND SOYBEANS.

How do we economically incorporate cover crops across Minnesota production acres?

Row crop production leaves soils bare from fall until spring, making it easy for rain and snowmelt to wash soil and nutrients into nearby waters. Cover crops can reduce both erosion and nutrient loss. Models suggest that cover crops can reduce by up to one-third the nitrogen, phosphorus and sediment entering our waters. Research is needed to improve cover crop technology; characterize nutrient, erosion and water retention impact; quantify economic costs and benefits; and develop and improve cover crop seed varieties suitable for Minnesota.

What influences private landowners to participate in watershed strategies to protect water resources?

Comprehensive watershed management plans developed under One Watershed One Plan will create management targets and goals for large areas that include privately owned lands. To meet watershed goals, we will need landowners to take action to protect and restore water resources. On farms, this could mean adoption of best management practices and the use of perennials or cover crops; on working forests, this could mean protection of mature habitat; and on wellhead areas where drinking water supplies recharge, this could mean placing sensitive areas into conservation programs. The success of watershed management not only requires sound biophysical science and consistent monitoring to provide data, but it also requires uncovering and addressing social barriers that impede change. We need to more strategically integrate social science to help us understand what motivates landowners and businesses to take voluntary actions, and how we work together across watersheds and communities to protect shared water resources.



MINNESOTA NATURAL RESOURCES CONSERVATION SERVICE

Goal #4: Ensure Resilience to Extreme Rainfall

Ensure we are resilient to extreme rainfall

Extreme rainfall has increased during the past century in Minnesota. This trend is expected to continue, increasing flooding and erosion, reducing water quality, and affecting transportation, agriculture, human health and infrastructure. At the same time, flows in many Minnesota rivers and streams have increased, making some systems more vulnerable to flooding and contributing to ongoing erosion that affects ecosystems and recreation. These increased flows result from both increased rainfall and human land use. Historic wetland drainage and expansion of artificial drainage networks on agricultural and urban lands contribute to increased stream and river flows. While reversing climate change that contributes to increased occurrence of extreme rainfall will take global action over decades, we should act to implement land use practices that make us more resilient now.

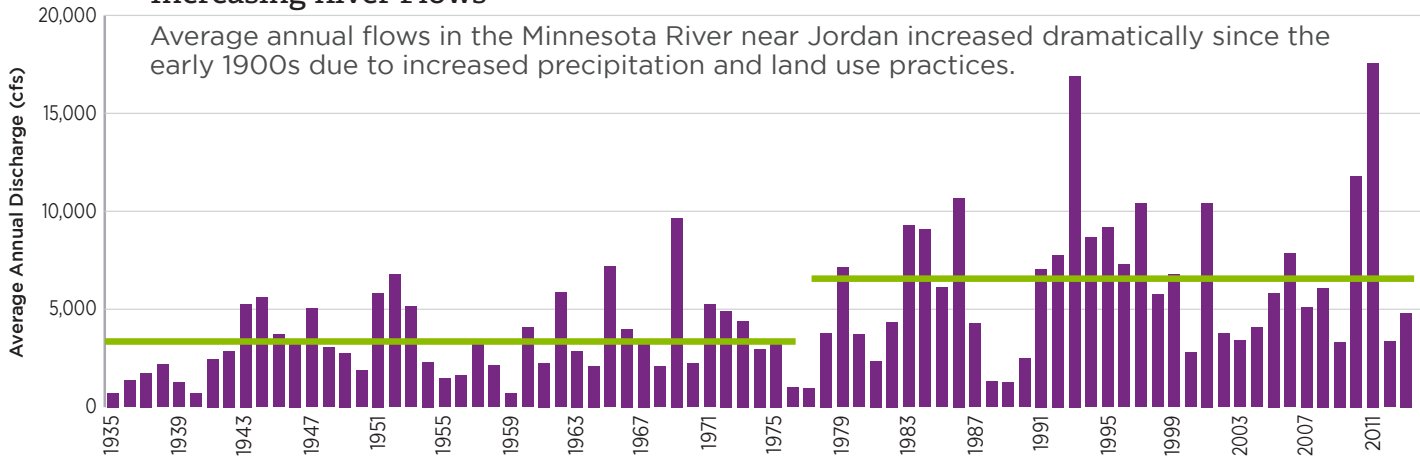
Preserving the function of floodplains will protect inland areas. Floodplains can be restored to their natural state or made into public parks. We can manage our drainage systems to make streams and rivers more resilient to heavy rains. And we can assess vulnerabilities of our highways, homes and other infrastructure to improve their resilience to extreme rainfall and floods.

Tile drainage systems route excess water that falls onto a farm field into ditches and rivers. This protects crops that need the land drained before crop damage occurs. Water quality and flow monitoring in rivers and streams have shown increasingly erosive flows, flooding, and contamination from excess sediment and nutrients related to engineered drainage. Tile systems are critical to agricultural production, but could be improved to protect crops while minimizing potential water impacts.


ST. CLOUD

Increasing River Flows

Average annual flows in the Minnesota River near Jordan increased dramatically since the early 1900s due to increased precipitation and land use practices.



SOURCE: MPCA

Increasing River Flows

Floods can harm human health in many ways. They can contaminate drinking water with hazardous substances. Flood-damaged homes can harbor mold and cause respiratory disease. As people are displaced by floods, a cascade of disruptions occur that can interfere with access to health care or affect mental health.

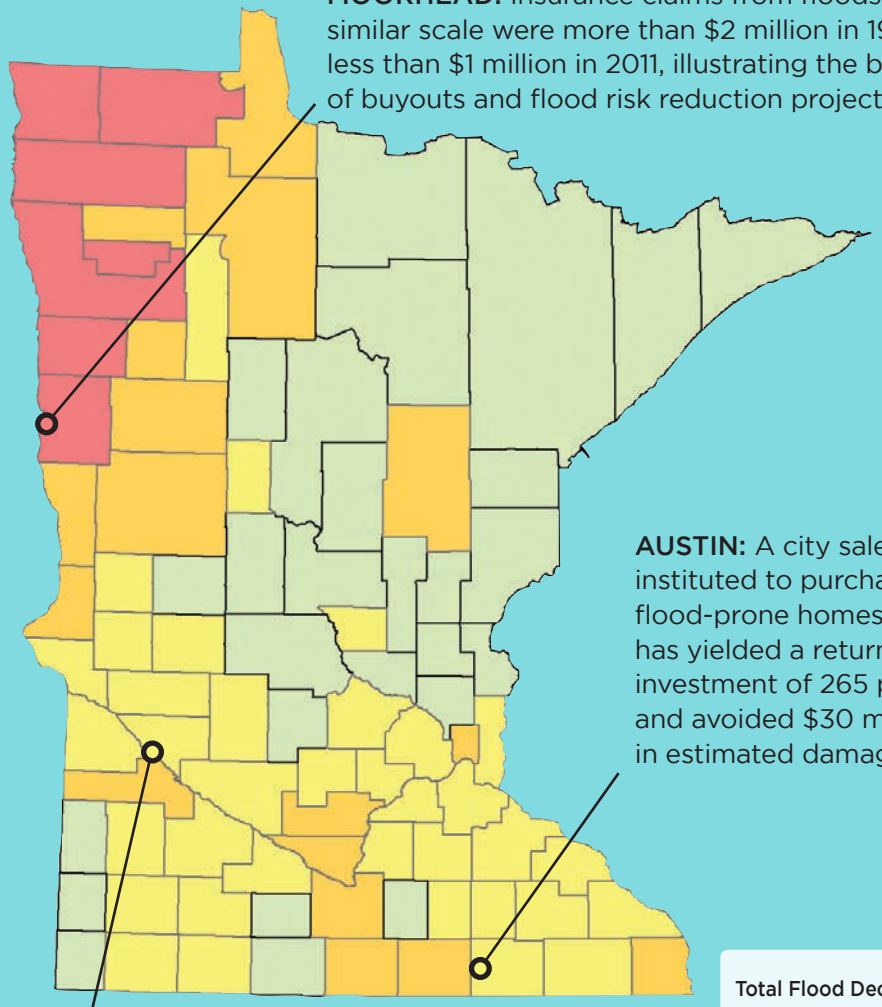
In the past 15 years the Federal Emergency Management Agency has spent nearly $266 million to repair flood damage in Minnesota, while state and local governments have spent $84 million.

JAY COOKE STATE PARK

Minnesota Has Experienced Numerous Floods

Number of flood disasters by county (1964–2014).

MOORHEAD: Insurance claims from floods of similar scale were more than $2 million in 1997 but less than $1 million in 2011, illustrating the benefits of buyouts and flood risk reduction projects.



AUSTIN: A city sales tax instituted to purchase flood-prone homes has yielded a return on investment of 265 percent and avoided $30 million in estimated damages.

MONTEVIDEO: Buyouts had a 747 percent return on investment, saving an estimated $8 million in damages for an investment of $1 million.

Total Flood Declarations

- 4 – 8
- 9 – 12
- 13 – 16
- 17 – 24

SOURCE: HSEM/DPS

Voluntary Solutions

Reduce risks by removing homes and businesses from floodplains

After floods, some property owners may choose to have their local government buy and demolish their homes and businesses. The government then returns the land to open space. Return on investment for such buyouts is huge, including avoiding direct property damage, displacement costs, individual assistance and infrastructure costs, and indirect costs and suffering for communities and individuals from repeated flood damage. Local governments can pursue funding from federally funded, state-run programs and other grants.

HAZARD MITIGATION

is any action that eliminates or reduces future risk to human life and property from natural and human-caused hazards.

Flood hazard mitigation in the wake of the 1997 flood reduced the risk of future harm to homes in East Grand Forks.

East Grand Forks
BEFORE

East Grand Forks
AFTER

SUCCESS STORY

East Grand Forks on the Red River

Since 1997, there have been six floods in the Red River at the 50-year flood elevation or higher, with three near or exceeding the 100-year flood elevation. The private and public costs have been extremely high, and it has taken months, and in some cases years, for life to return to normal. East Grand Forks completed many buyouts and installed a flood barrier that can be put into place with impending flooding. Residents filed more than $32 million in flood insurance claims in 1997. Due to flood risk reduction efforts, they have filed less than $10,000 in flood insurance claims since then.

Improve community resiliency and flood preparedness

Communities can build resilience to flooding by establishing ties with emergency assistance resources and cultivating networks within the community to provide support during emergencies. Through the **MnWARN** system, water, wastewater and stormwater utilities damaged by natural or man-made disasters can get emergency assistance from other municipalities or the Minnesota Rural Water Association in the form of personnel, equipment, materials and associated services.

FROM 2010 TO 2014, THE MnWARN SYSTEM WAS ACTIVATED
50 TIMES.

We can build resilience in our communities through neighborhood groups, local governments and emergency responders. If we develop formal and informal connections ahead of time, we will be better prepared when disaster strikes.

Regulatory Solutions

Require communities to have recovery plans

A disconnect exists in many places between county emergency management plans and community planning processes. Counties are required to develop hazard mitigation plans to request federal grant money. However, cities and towns are not always part of this process and are not required to have disaster plans. When a disaster occurs, cities and towns apply for aid to rebuild, which is paid for with a cost share of 25 percent from the state and 75 percent from the federal government. Too often, infrastructure is rebuilt only to be destroyed in the next flood. Requiring local governments to have plans in place or to participate in county planning to receive the full cost share from the state would ensure that funds go toward key priorities that make our communities more resilient and healthy for all.

Floods can cause sewage to bypass wastewater treatment facilities, leading to the release of minimally treated or untreated wastewater.

Put codes and standards in place to best leverage federal disaster funds to rebuild the right way

Local governments may obtain federal funding to restore damaged infrastructure after a state or federal disaster is declared. However, federal disaster funds don't incentivize rebuilding in a more resilient way — in fact, local governments can be penalized for not rebuilding to pre-disaster conditions unless state codes and standards dictate otherwise. Minnesota already requires construction projects covering more than an acre to have erosion control and ground surface stabilization. Communities can use federal disaster money to rebuild with those controls in place, reducing runoff and making them more resilient to floods. Other codes and standards that could be put in place include:

- Require use of best available updated rainfall data (NOAA Atlas 14) to estimate infrastructure capacity for handling precipitation.
- Require regional engineering best practices to address repetitive damages, such as washout of undersized roads and culverts.

RUSHFORD FLOOD

System Change

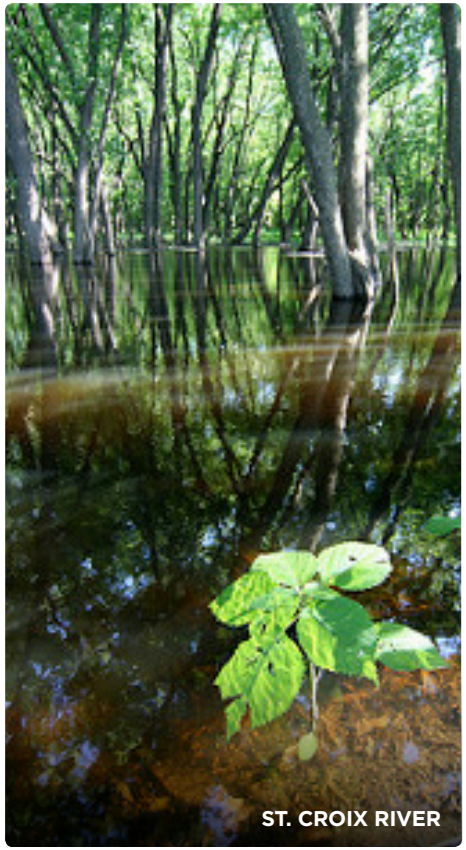
Improve watershed resilience through watershed management, including agricultural drainage systems

Drainage systems help maintain ideal soil moisture on farmlands and maintain the function of other built environments. However, they typically also carry sediment and excess nutrients to waterways and can alter the hydrology of local surface water systems. To maintain the benefits of drainage systems while better protecting water and decreasing vulnerabilities to extreme rainfall, we can manage these many small systems as a holistic water system. On farmlands, water that would otherwise drain off the land could be stored in control structures at the field drainage outlets when excess water would increase stream and river flows too much. Addition of cover crops, buffers or perennials can also reduce erosive stream flow and protect water quality. Water can also be held on farmland or other parts of watersheds by restored or constructed wetlands or constructed water storage ponds. On the scale of a watershed, reservoirs can be built to collect and hold drainage.

In Minnesota there is a lack of accountability for comprehensively addressing drainage systems as part of watershed management. To manage for a more resilient landscape we could:

- establish river flow criteria that will lead to less erosion and transport of sediment near rivers
- continue comprehensive watershed management that increases watershed resiliency to wet periods, while reducing downstream effects
- increase private investment in best management practices for storing water on the landscape.

We do not know the total amount of tile drainage added to our cropland soils. In 1999, the Bois de Sioux Watershed District approved permits for 2.9 miles of subsurface tile. In 2014, it signed off on 2,462 miles. In the intervening years, it permitted 13,179 miles of agricultural drain tile.



ST. CROIX RIVER

Protect the natural functions of floodplains

Flooding is a natural process that increases soil fertility, creates wetlands and fish spawning areas, enhances fish habitat and bank stability, maintains vegetation, and shapes habitat-enriching channels, islands and backwaters. Floodplains — low-lying areas susceptible to natural flooding — store floodwaters and stormwater, provide valuable habitat for native plants and animals, and protect water quality.

Floodplains also have value for farming and development, but as we adapt them for human use, the ecosystem services they provide diminish or disappear. Extensive filling of floodplains can cause floodwater to move more quickly downstream, threatening property and life. Removal of natural vegetation from floodplains can make nearby streams "flashier" — more prone to rapid changes in flow — and increase stream-bank erosion. Straightening of meandering waterways also increases erosion and speeds stormwater flow while destroying valuable habitat.

We can maintain or restore the natural functions and benefits of these systems. Recognizing the value of floodplains, some local ordinances and watershed district rules now incorporate standards to protect them, such as:

- limiting impervious cover on the floodplain
- prohibiting or limiting fill or requiring an equivalent area be set aside to store floodwater
- maintaining or replanting perennial vegetation along stream banks
- protecting the areas in which streams naturally meander.

More Study

How vulnerable are we to extreme rain?

Storm sewers help keep streets and parking lots clear of water, but they also carry sediment and pollution to nearby waterways. When they back up, the resulting flooding can disrupt transportation and commerce. To boost preparedness for extreme weather, we need to create a comprehensive storm sewer database that allows us to identify areas of concern that need attention during extreme events.

Similarly, as weather becomes more severe, we need to assess and rank the vulnerability of roads, bridges and culverts around the state to storms and floods so we can prioritize efforts to reduce risk. A Minnesota Department of Transportation pilot project recently tested a method for ranking the vulnerability of highway infrastructure to increased heavy rainfall and identified preferred adaptation options for three future climate scenarios based on life-cycle cost. Expanding this analysis would help the state, cities, counties and tribal governments focus investment on the most vulnerable and critical infrastructure.

RUSHFORD FLOOD

How can we best plan for rainfall and flooding?

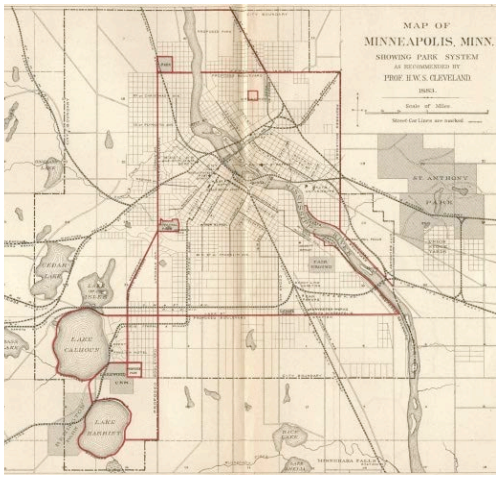
Recent extreme weather makes it clear that existing statistical methods and data are not sufficient for future planning; we need the most up-to-date trends and projections of future conditions in order to design resilient infrastructure, emergency responses and land use. Questions we should consider when we build:

- **How will the climate change at watershed and local levels?** Global-scale climate models don't provide enough detail for engineers and planners designing local infrastructure. We need downscaled climate models that will provide a level of detail relevant for local planning.
- **What is the likelihood of extreme precipitation?** Until recently, engineers and planners used precipitation data estimates that had not been updated since the 1960s. The recently released Atlas 14 provides more relevant data that should be incorporated into all projects in the state.
- **Where have stream and river flows increased?** We need to incorporate up-to-date flow data for streams and rivers to properly design bridges, culverts, storm sewers, ponds and ditches. The U.S. Geological Survey makes high-quality flow data available, and engineers should incorporate these updates to include the latest 10 years of flow data.

SUCCESS STORY

Twin Cities Waterways

Most of the lakes and riverbanks in Minneapolis and St. Paul have been incorporated into public parks, thanks to planning that started in the 1880s. In Minneapolis, record precipitation in 2014 led to the highest lake levels in 130 years. Damage to structures and disruption of business was minimal because the flooding was limited to parklands.



1883 Map of recommended Minneapolis park system

Lake Hiawatha/Nokomis and golf course area on June 20, 2014

Contaminants of Emerging Concern

We need to protect drinking water and ecosystems from harmful levels of contaminants of emerging concern.

Evaluating and managing risk in the face of uncertainty

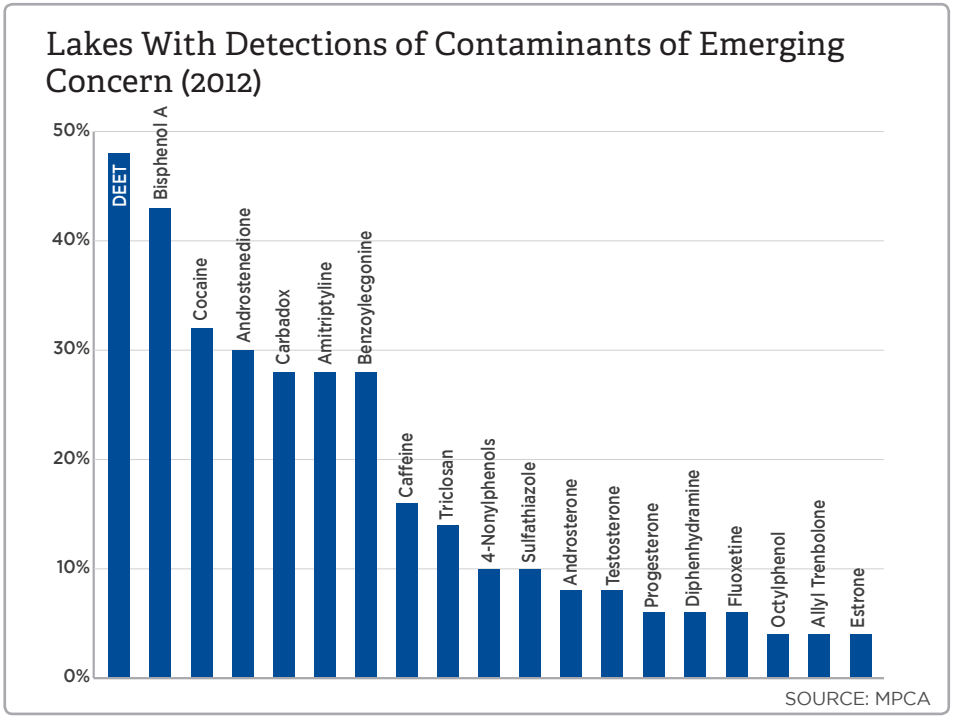
Individuals and industry use tens of thousands of chemicals in a vast array of products and applications, including household cleaners, medications, lawn care chemicals and personal care products. Sometimes, chemicals we never suspected end up in places we never expected, including our lakes and rivers. These "contaminants of emerging concern" (CECs) are found across Minnesota in surface water, groundwater and some sources of drinking water. Many CECs have not been evaluated for the risks they pose to the environment, plants and animals, or human health.

Pharmaceuticals. Medicines used to prevent and treat illness in humans and animals are designed to interact with our bodies. This can have unintended consequences for aquatic life in lakes and streams.

Household and personal care products. This category includes household cleaners, laundry soaps, lotions, body washes, cosmetics and fragrances. Some personal care products contain microbeads, which are difficult to clean out of wastewater.

Chemicals used in manufactured products. These include chemicals used in plasticizers, coatings, dyes, fire retardants, building materials, textiles, electronics and plastic containers.

Pesticides, veterinary and other animal care products. These undergo testing and registration to ensure they are safe. Emerging concerns, however, have arisen around whether buildup of these chemicals in water impact aquatic ecosystems.



New contaminants, evolving science

Scientists in Minnesota rely on evidence-based practices to identify, monitor and assess the potential risk of many emerging contaminants. This improves our understanding of the subtle ways chemicals can affect the health of people and other organisms. For example, we now know that exposure to low levels of some chemicals can interfere with endocrine system function.

However, many chemicals can't be identified, monitored or evaluated in the environment with existing knowledge and practice. As a result, scientists investigate and develop alternative approaches to address these contaminants. State agency scientists use monitoring, exposure, toxicological and other data to decide which contaminants require the most attention. Clean Water Fund dollars advance our ability to detect contaminants at very low levels, develop new risk assessment and screening methods, and investigate ways to reduce CECs in wastewater.

What can we do?

Most CECs do not enter our environment through purposeful or negligent pollution — they enter our environment when we use products that contain these chemicals. Businesses, government agencies, legislative bodies, non-governmental organizations and citizens can prevent chemicals of concern from getting into the environment through:

Green chemistry. Design products and processes that minimize the use of hazardous chemicals and reduce the negative impact of chemistry on the environment.

Voluntary or incentive-based changes in industrial and retail practices. Modify manufacturing processes and products to use less harmful chemicals, create less waste and manage environmental releases.


WASHINGTON COUNTY

Consumer action. Advocate for better information about chemicals in products, buy safer products, and properly use and dispose of products containing CECs.

Product bans or limitations. Since 2009, Minnesota has required some CECs to be removed from products, including BPA from baby bottles and children's products, triclosan from antibacterial cleansers, and some flame retardants from children's toys and household furniture upholstery.

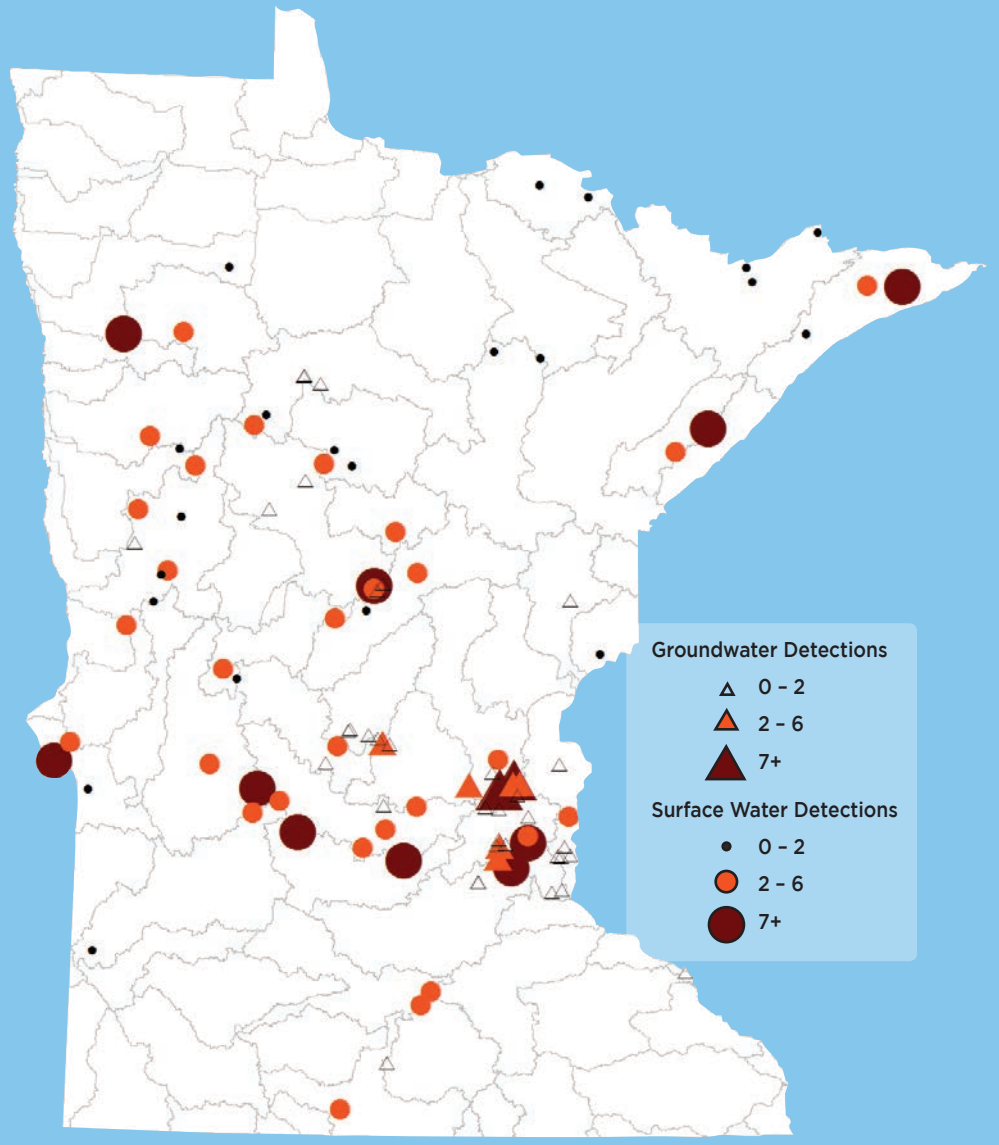
Improved ingredient disclosure. Help consumers make informed choices about products by disclosing potentially harmful chemicals, particularly for personal care and children's products.

Environmentally preferable purchasing. Use the purchasing power of governments and other large organizations to stimulate market demand for products and services that rely on fewer harmful chemicals and create less waste.

Improved premarket safety evaluation for chemicals. Support updated regulations to ensure the safety of a chemical before it is used in consumer products.

Locations Where Contaminants of Emerging Concern Were Detected in Groundwater and Lakes

The size of the symbol indicates the number of contaminants detected each sampling location. (2012 & 2013)



SOURCE: MPCA

Minnesota's Water Technology Industry

Bringing clean water to the world: Minnesota's water technology industry

Access to clean water is a global concern. The need is growing for water technology products and services to address environmental degradation as well as resource constraints. Minnesota's growing water technology industry is uniquely positioned to meet it. Minnesota ranks in the top 10 states for patents and exports for services and products that increase water use efficiency, support water reuse and treat drinking water. This leadership results from the synergy of entrepreneurs, cutting-edge research and development, a world-class university system, and a significant presence of industries in the state.

Minnesota's water technology industry includes a variety of small and large companies that create or provide products or services to improve the use, quality and flow of water. Industry activity in the state includes manufacturing; research and development; management, sales and distribution of water-related products, components and services; and conservation, monitoring and management of water resources.

Types of Industries	Products & Services	Examples in Minnesota
Treatment Products & Services	Filtration/purification, disinfection, desalination, aeration, contaminant detection	**Minnepura Technologies**, launched in 2014, uses bacteria-based biotechnology to purify contaminated water. This technology is based on work by University of Minnesota researchers.
Infrastructure Products & Services	Pumps, pipes, tile drainage, water & sewer line construction, agricultural water management	**IrriGreen** manufactures landscape irrigation systems that use digital technology to save water.
Efficiency Products & Services	Meters and controls, leak detection, water conservation, energy efficiency, low-flow fixtures	**Water Meter Solutions** manufactures sensors to detect leaks in toilets and sends a wireless signal to a maintenance crew.
Public Water Utilities	Water & wastewater treatment facilities, water quality monitoring, stormwater management, watershed districts	**Chisago Soil & Water Conservation District** is a local government that manages natural resources.

TONKA WATER

Water-Enabled Industries

In addition to companies that create and sell water technology services and products, Minnesota has abundant water. This water is part of what makes Minnesota competitive for business. Water-intensive industries include agriculture, fishing, manufacturing, food production, microbrewing, mining and shipping.

Photo by Jeffrey Thompson / Minnesota Public Radio News.

Water Technology and Innovation in Minnesota

3M offers technology that allows utilities to insert a robotic spray head into a water transmission line and apply a liner that helps prevent corrosion and tuberculation and seals cracks, pinholes and pitting. The pipe can often be reinstated in a single day. This technology has tremendous potential: The U.S. Environmental Protection Agency estimates U.S. municipalities will need to spend $247.5 billion over the next 15 years to fix deteriorating water pipes.

3M™ Scotchkote™ Pipe Renewal Liner 2400

Ecolab is a global leader in water, hygiene and energy technologies and services. In 2014, Ecolab partnered with the Cold Spring, Minnesota, plant of Gold'n Plump to implement an innovative poultry washing process that saved the company 68 million gallons of water.

Dow Water & Process Solutions provides innovative technology-based solutions to a broad spectrum of water issues, including making seawater fit for human consumption and reducing and reclaiming water used in industrial processing.

Pentair designs and manufactures advanced technologies to help customers produce more food, energy and efficiencies from each drop of water. For instance, since 2005, Pentair's pool pumps alone have saved enough energy to power 548,000 homes for one year.

Over the past 59 years, Tonka Water designed, manufactured and installed more than 2,300 individually designed water treatment systems for municipalities across North America.

Economic Impact of Minnesota's Water Industry

Industry growth

Minnesota's water industry employed 13,500 workers in the first quarter of 2014. Industry growth of 13 percent between 2004 and 2014 was three times faster than overall state employment growth of 4 percent.

What do water tech businesses look like?

- Minnesota has more than 1,000 individual water business locations.
- About 80 percent of Minnesota water establishments have 10 or fewer employees.
- About 97 percent of establishments have fewer than 50 employees.
- The remaining 3 percent are large firms that comprise nearly half of the total water industry employment.

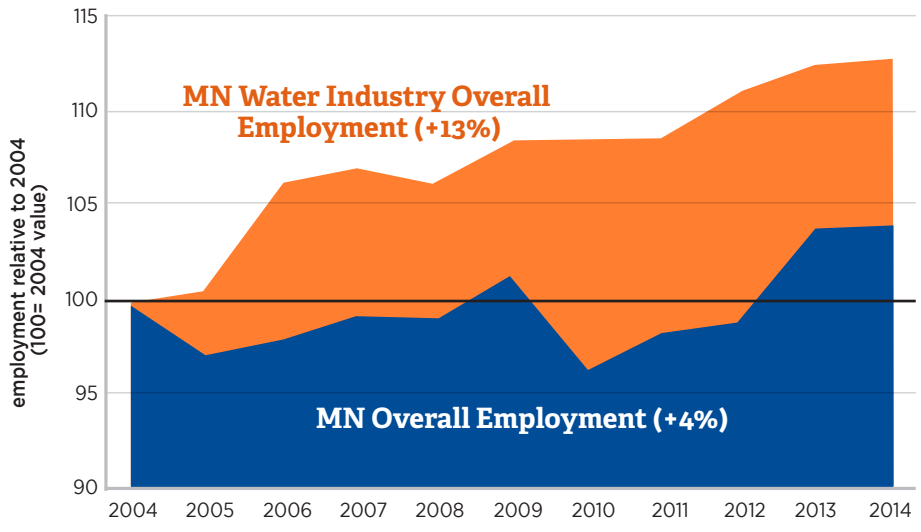
Wages

Wage data is one way to evaluate the potential for industry growth to raise the living standards of hard-working Minnesotans. Minnesota water technology firms paid more than $885 million in wages in 2014, up 15 percent from 2004 (adjusted for inflation). Average annual wages in the water industry were $65,500 in 2014, or 27 percent higher than the statewide average annual wage of $51,600. As this industry grows, it will open additional well paying jobs to Minnesotans.

Workers in the water technology industry

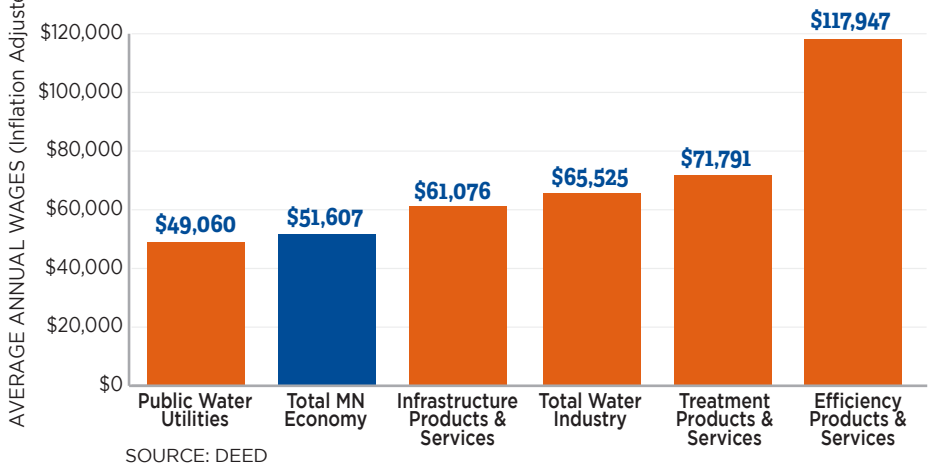
tend to have science, engineering or facilities management backgrounds. Minnesota has a particularly high concentration of water treatment plant operators, hydrologists and filtering machine operators. These water-related occupations offer a variety of opportunities for Minnesotans with all levels of education. Several water-related occupations need only a high school diploma or associate degree, while others require a bachelor's degree or higher. A below-average concentration of engineers in Minnesota may indicate a workforce development opportunity in the state.

Minnesota Water Industry and Total Employment



SOURCE: DEED

Average Annual Wages by Water Segment, Minnesota 2014



SOURCE: DEED

Leading in Innovation

Innovation is crucial to meet demand for products that address global water challenges.

Patents

Minnesota universities and companies develop new technologies, processes and materials that allow industries to operate more cleanly and efficiently. Home to some of the nation's top researchers and inventive firms, the state ranked 10th in water technology patents and third in patents per capita in 2014.

Exports

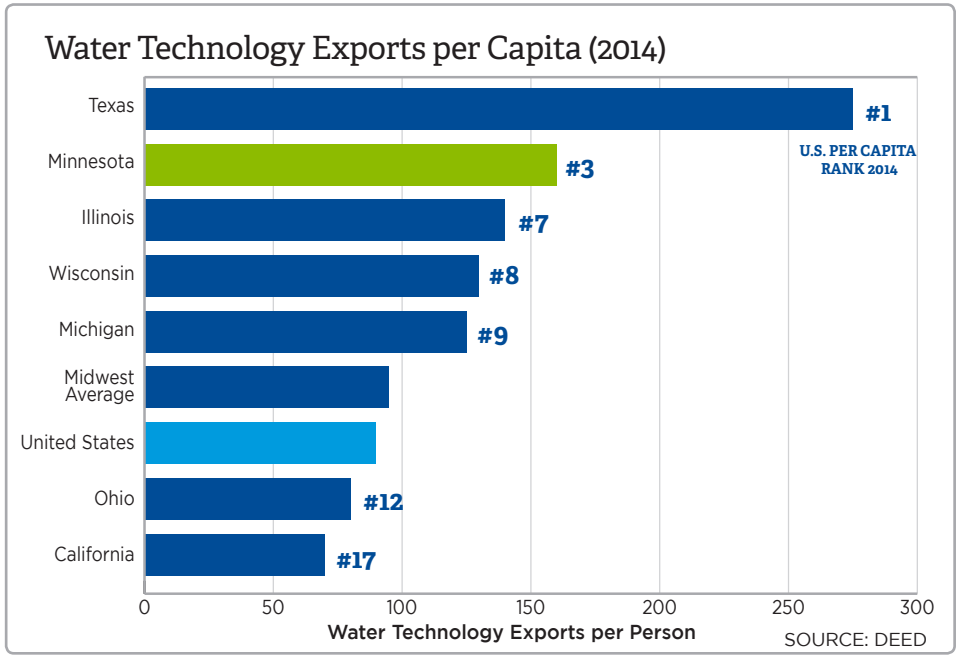
Minnesota is one of the top water-technology exporting states. With more than $870 million in international water-related technology exports, Minnesota ranked eighth nationally and third in per capita in exports in 2014. Minnesota had about $160 in water technology exports per person in 2014, behind only Texas and Delaware. These exports add value to the state's economy and demonstrate the international strength of our water technology industry.

Eduction and research

Minnesota's public and private colleges and universities play a critical role in training the next generation of industry workers. These institutions, along with private companies, drive water technology innovation with cutting-edge research.

For example, The University of Minnesota's Discovery, Research, and Innovation Economy (MnDRIVE) program funds research in emerging industries, such as a project that's working to develop ways to use organisms to clean up polluted water and collaborating with industry to apply this research to solve business and environmental problems. Major state investments augment research and development with programs such as the Legislative-Citizen Commission on Minnesota Resources and the Clean Water Fund.

UNIVERSITY OF MINNESOTA DULUTH



RESEARCH IN ACTION:

In 2013, **American Peat Technology** signed an agreement with the University of Minnesota Duluth's Natural Resources Research Institute. Together, these partners are exploring new ways to use peat to remove pollutants from mine water.

Minnesota Water Tech by the Numbers (2014)

SOURCE: DEED

Water technology industry employment grew **three times faster** than overall employment in the previous decade.

Minnesota had more than **$870 million in water-related technology exports.**

Average **annual wages** in the water technology industry were **27% higher** THAN THE STATE AVERAGE.

13,500 Water Industry Employees

$885M Water-Related Payroll

10th Nationally in Water Patents

3rd Per Capita Water-Tech Exports

Minnesota's Emerging Water Cluster

Minnesota has a strong core water industry that grew three times faster than industry overall in the state in the past decade. This growth is due in no small part to the state's position as headquarters for several of the world's leading water industry companies, as well as for life sciences, biotechnology, and food and agriculture businesses that place high demand on water products. In addition, water industry leaders are increasingly engaging with each other and with public partners to explore ways to grow the state's water industry. These dynamics indicate an emerging water cluster in Minnesota. By growing Minnesota's water cluster, the state can form public-private partnerships, drive economic development and support local jobs.

What is a Cluster?

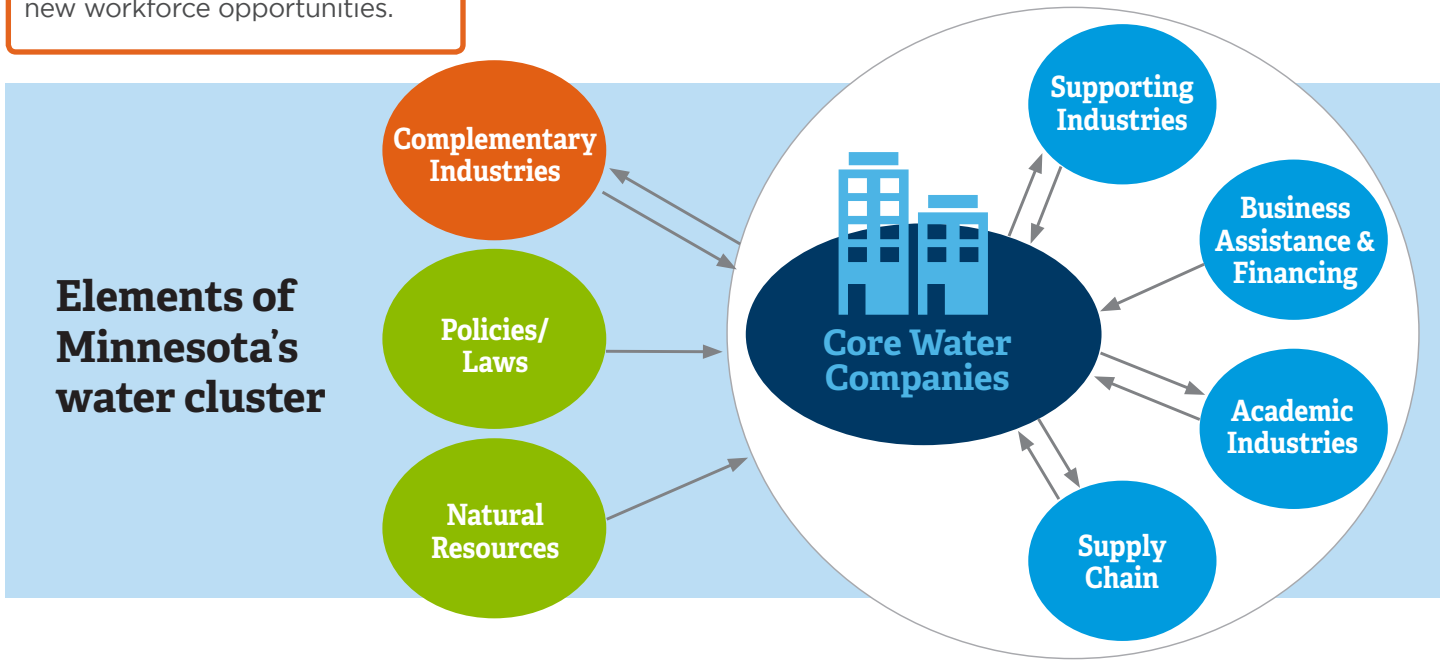
A cluster is a geographic grouping of companies, research institutions, public organizations, specialized talent and local assets focused on a specific sector or type of enterprise. Clusters can be a powerful mechanism for increasing productivity, transferring and leveraging knowledge to foster innovation, sharing skills and experience to improve commercialization of products, and increasing market share. By encouraging clusters rather than focusing on individual firms, a region can increase its competitiveness, drive innovation, boost production of tradable products and services, and create new workforce opportunities.

We Can Grow the Minnesota Water Cluster by:

- fostering partnerships
- incubating new technologies
- pursuing federal grants and private investment
- creating a Minnesota water tech brand

Connecting Minnesota's water cluster

The Minnesota Department of Employment and Economic Development and Minneapolis Saint Paul Regional Economic Development Partnership (Greater MSP), a planning organization committed to growing the regional economy, host an annual Water Technology Business Summit. In 2014, the inaugural Summit brought together 150 public and private sector leaders to talk about strategies for developing the industry. Efforts like these build the networks necessary for a cluster to thrive.



How we use our land affects our water

LAKE SUPERIOR, HOVLAND

More information

General

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