DEPARTMENT OF NATURAL RESOURCES

Water Availability and Assessment Report 2025

Appendix C to the 2025 EQB Water Policy Report | 9/15/25

Cover photo: The Cloquet River, Riverlands State Forest.

DEPARTMENT OF NATURAL RESOURCES

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CLEAN WATER LAND & LEGACY AMENDMENT

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Introduction

The Land of 10,000 Lakes, the Mighty Mississippi and Lake Superior — the largest freshwater lake in the world — are just some of Minnesota's water resources woven into our state's identity. Our water resources provide habitat, recreational opportunities, drinking water supplies and economic vitality. Minnesotans value these resources as part of our way of life.

This report explores water in Minnesota's atmosphere, economy, communities and landscapes from 2020 to 2025. It presents data and information on the amount of water in and flowing through Minnesota and describes how individuals, businesses and communities use that water. The report also summarizes water law changes, supporting the Minnesota Department of Natural Resources' (DNR) efforts to ensure sustainable water use.

The water resources data and information in this report lead us to the following conclusions:

1. **Climate**: Minnesota's climate is changing outside of the range of normal variation. The trend toward more precipitation continues, even when accounting for recent dry years in the state. The dry years are unusual because they had more precipitation than any other dry period on record in Minnesota. Minnesota also experienced multiple shorter episodes of significant drought and significant flooding.
2. **Water use**: The total volume of water used decreased over the last 20 years, most notably in the energy sector due to reduced water use in power plants. Statewide, groundwater use increased by one-third in the drought years of 2021 to 2023, largely due to irrigation during dry periods.
3. **Streams**: Stream flows were generally normal to above normal compared to historical records, with notable swings between extreme highs and lows.
4. **Lakes**: Lake levels have generally been normal but show similar swings between extreme highs and lows as streams.
5. **Wetlands**: Around the state, there was a slight increase in the acreage of wetlands, and some wetlands are shifting toward wetter types. This is likely due to wetland restoration policies and programs.
6. **Groundwater**: Groundwater levels have been generally stable around the state, although some locations show decreasing trends. In some places, this is due to demand for groundwater exceeding its recharge; in others, it is from increasing seasonally intensive groundwater use.

Assessment and availability of Minnesota's waters

In this report, we describe water availability in terms of elements seen on the landscape: climate and precipitation, streams, lakes, wetlands and groundwater, and how we use water. Precipitation either soaks into the ground or runs off into lakes, rivers and wetlands. Much of the water that infiltrates the ground is stored in the soil to be taken up by plants. Evaporation from plants and land and water surfaces returns moisture to the atmosphere, which perpetuates the hydrologic cycle. Each of these components is influenced to some degree by human activities at or near the land surface. Streamflow, storage in wetlands and lakes, and groundwater use can be influenced by people; however, natural variability of other components, such as drought, flood and the geographic distribution of aquifers, cannot be controlled. This variability presents challenges for the long-term sustainability of both human and ecological water needs. The following sections describe Minnesota's water availability from 2020 to 2025 through trends in climate, surface water, groundwater system, and water use.

Overview of climate trends and projections

Climate is a fundamental driver of Minnesota's water supply. The amount of precipitation received and moisture lost through evaporation determines surface and groundwater quantities. Wet periods generally increase surface and groundwater levels, whereas dry periods decrease levels. Understanding Minnesota's climate can provide important insight into water availability issues now and in the future.

Minnesotans are accustomed to cold and snowy winters, along with warm and humid summers, but also know that any season can be far warmer, colder, wetter or drier than normal. The high variability that we expect from Minnesota's climate can make it difficult to notice where, when and how climatic conditions have changed in our state. **More than 130 years of climate data, however, clearly show widespread changes outside of the past range of normal variation are already underway in Minnesota.**

Indeed, Minnesota's climate is changing rapidly, and more changes are coming. In the past several decades, our state has seen increased rainfall and snowfall, heavier downpours and snow, and substantial warming, especially during winter and at night. Winter rain is now more common than at any other time on record, which, combined with warmer winters, has decreased the average depth of snow cover. Although significant drought shows no long-term increases, it has dominated the growing seasons of the early 2020s, representing a major shift from the record wetness of 2019 and the 2010s in general.

An overwhelming base of scientific evidence projects that Minnesota's climate will see additional, significant changes through the end of this century, with even warmer winters and nights, and even larger precipitation events — along with the likelihood of increased summer heat and the potential for longer dry spells. Planning for the future of Minnesota's water must account for the likelihood of both wet and dry hydroclimatic extremes.

Wetter and warmer conditions

Minnesota has become wetter and warmer in the past several decades. Each of the 10 combined wettest and warmest years on record occurred after 1998 (Figure 1). In fact, since 1970, all but two years had some combination of wetter and warmer conditions than 20th century averages. Minnesota's wettest year on record was 2019, with 2024 as the warmest year on record. Although the climate will vary from year to year, with occasional cool or dry years, climate scientists expect precipitation and temperature to continue increasing through the 21st century.

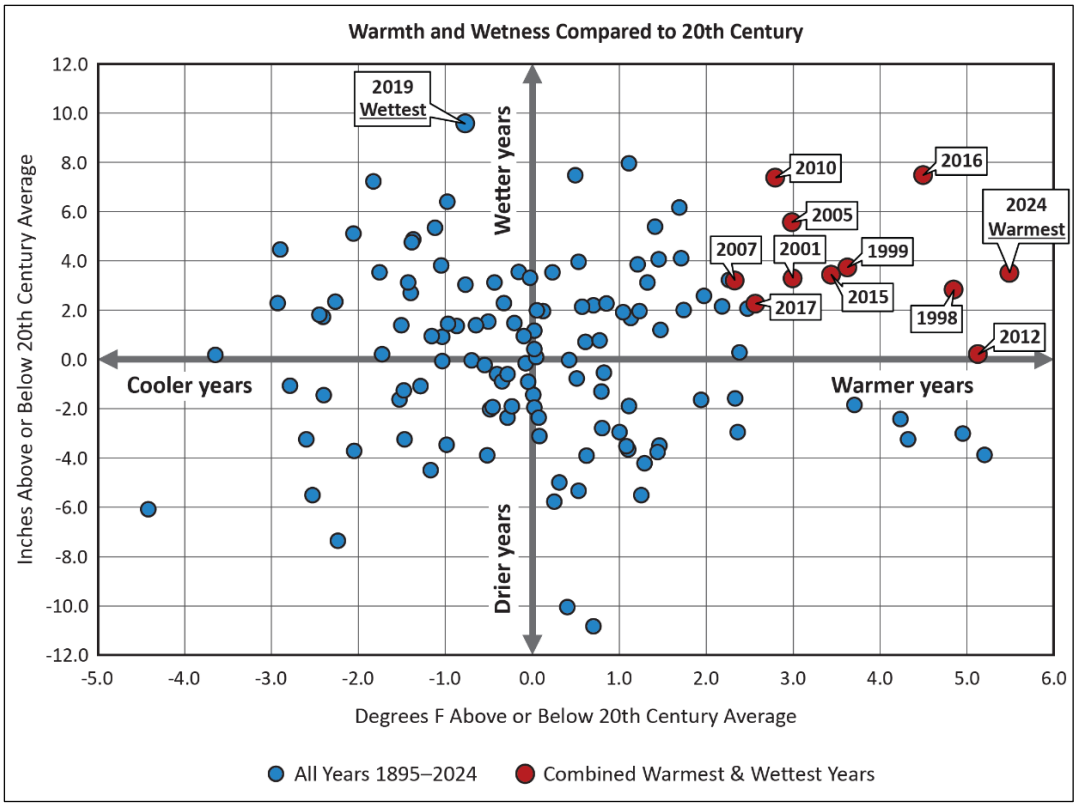


Figure 1. Plot of annual temperature and precipitation in Minnesota, with the combined warmest and wettest years labeled and shown in red.

Increasing total precipitation but with recent dry years, too

Minnesota's climate swings regularly from relatively dry to relatively wet periods, but, on average, the state has become about 3.5 inches wetter over the last 130 years. Minnesota experienced its wettest decade on record in the 2010s and its wettest year on record in 2019.

During the first half of the 2020s, however, dry conditions and drought were much more common than in recent decades. Annual precipitation for the state plunged below 30-year averages each year from 2020 through 2023, resulting in accumulated precipitation deficits of around 15 inches during the period. Although precipitation totals surged in 2024, the first half of the decade saw an average of 14% less precipitation than the 2010s.

The dry period of the early 2020s is too short to reverse the ongoing, more than five-decade trend toward increased wetness. Additionally, the early 2020s had more precipitation than virtually all other historical dry years in Minnesota. **Even when accounting for the recent drop in annual precipitation totals, the long-term trend toward more precipitation continues.**

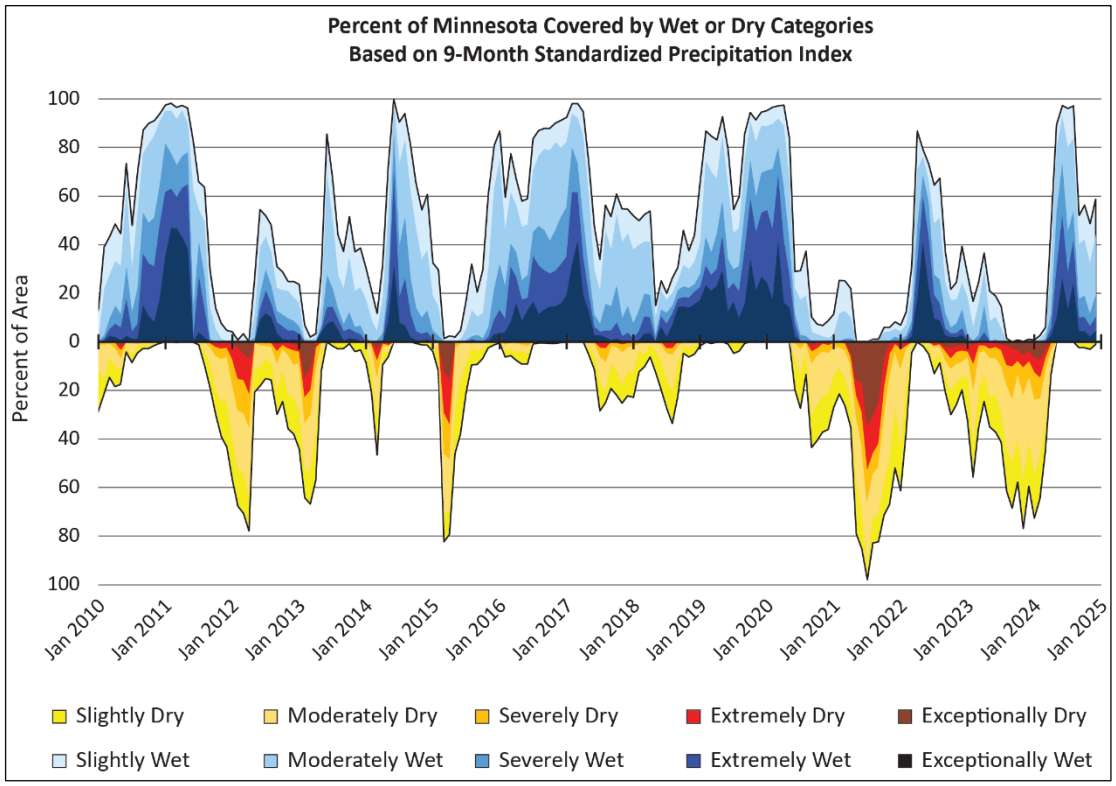


Figure 2. Proportion of Minnesota covered by different levels of wetness and dryness using the nine-month Standardized Precipitation Index. Produced by Minnesota State Climatology Office; data from the National Oceanic and Atmospheric Administration (NOAA), National Integrated Drought Information System.

Enhanced wet and dry extremes

Minnesota had more heavy precipitation in the 2010s than at any other time on record, with stations setting numerous all-time and statewide precipitation records. The excessive precipitation flooded communities and rivers, damaged infrastructure and left water standing in fields.

Since the 2010s, Minnesota's hydroclimate has become much more variable, with alternating extremes of wet and dry cycles (Figure 2). These wet and dry periods have varied in their timing, geographic extent and magnitude. **As a result, Minnesota has experienced multiple episodes of significant drought and significant flooding in a short amount of time, at scales ranging from localized to statewide.** Some areas have faced swings from the worst levels of drought on the U.S. Drought Monitor to historic or even unprecedented flooding in nine months or less (see Wet and dry extremes in the Rainy River Basin).

Climate projections for Minnesota show greater extremes of precipitation and also longer dry spells throughout the century. Planning for the future should account for even greater extremes of wetness and dryness than Minnesota has experienced recently.

Warmer but not hotter, yet

Minnesota is warming quickly, but mostly at night and during the winter. Annual temperatures have climbed by an average of 3.3 degrees (°) Fahrenheit (F) since 1895, but winters have warmed by 5.5°F and winter nights have warmed by 6.9°F, while summers have warmed by just 2.0°F, and summer daytime high temperatures have decreased slightly in southern Minnesota (Figure 3). Although the records go back to 1895, the vast majority of temperature increases have occurred since 1970.

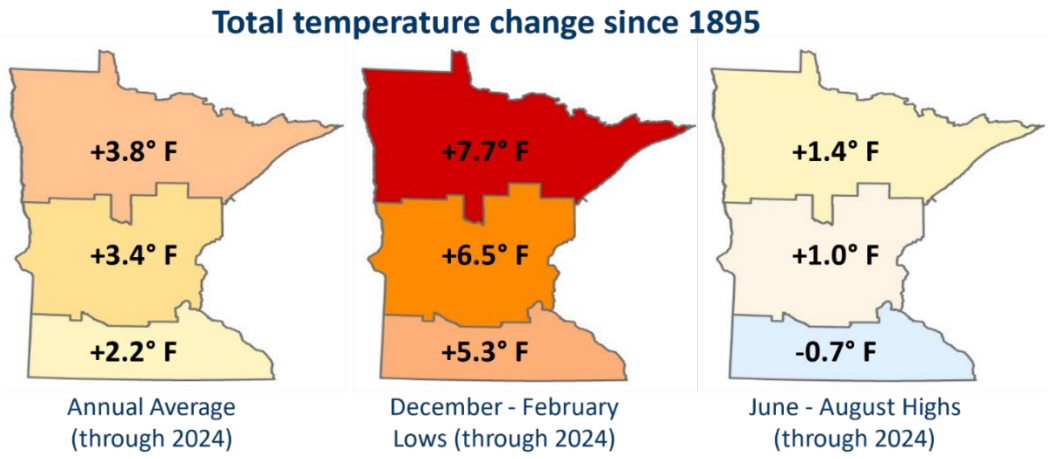
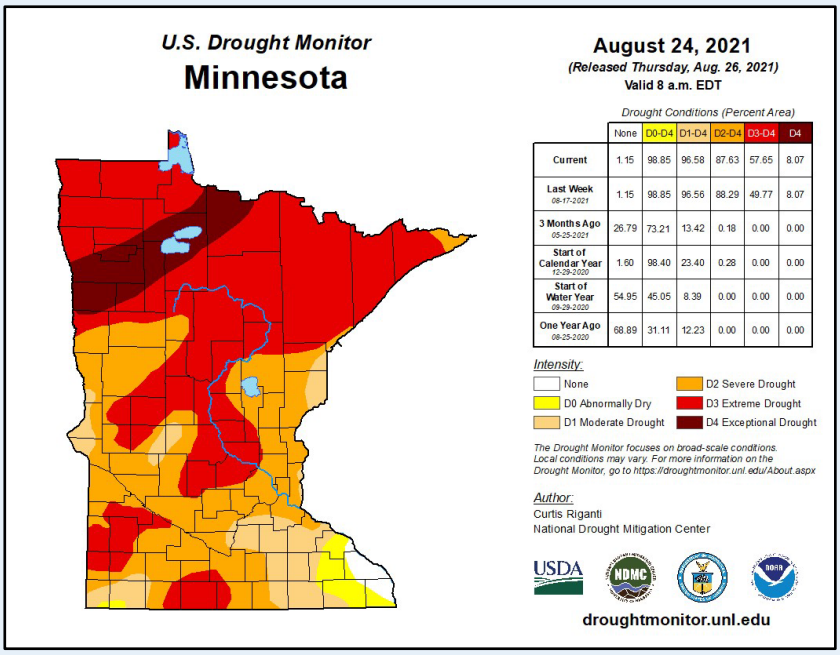


Figure 3. Temperature change by region produced by the Minnesota State Climatology Office — part of the DNR Ecological and Water Resources Division; data courtesy of NOAA National Centers for Environmental Information.

Winter cold extremes have become less frequent and less severe, while the state has observed no change in the frequency or severity of summer high temperature extremes. Extremes of humid heat have begun increasing, however, with many record and near-record heat index values observed in Minnesota in the 2010s and 2020s. Climate models are virtually unanimous in their predictions that hotter summers will arrive by the middle of this century (if not sooner), and recent trends suggest that humid heat waves will continue increasing in frequency and intensity. Winter is likely to continue warming faster than summer throughout the century.

Wet and dry extremes in the Rainy River Basin

The Rainy Lake and Rainy River area along the Canada-Minnesota border serves as a classic, recent example of wet and dry extremes occurring in rapid succession. From May through August 2021, the area received just half of its normal precipitation and ended up with the worst drought conditions since 1980. The next nine months, September through May, however, were by far the wettest on record for that period, exceeding normal precipitation by 80%. Rainy Lake rose to its highest levels in 115 years of record, with historic flooding on the Rainy River and Lake of the Woods. These two images show the effects of alternating extremes along the Rainy River.



Above: The U.S. Drought Monitor map for August 24, 2021. The dark red band across northwestern Minnesota extending through part of the Rainy River indicates exceptional drought, the highest level possible, and the worst drought conditions in the area since 1980.

Left: Historic flooding of the Rainy River just 10 months later, in June 2022, following several months of excessive precipitation falling in the basin. *Photo courtesy of Zachary Moore.*

Status of Minnesota's water use

Minnesotans get their water from both groundwater (underground aquifers) and surface water (streams, rivers and lakes). Total water use in Minnesota generally increased over the last decades of the 20th century. Since about 2005, water use has been declining, even as Minnesota's population has grown. In total, **Minnesota's water use has decreased over the past 20 years, from about 1.4 trillion gallons in the first decade of the century to about 1 trillion gallons at the start of the third decade** (Figure 4). This translates to an approximate 27% decline in overall water use.

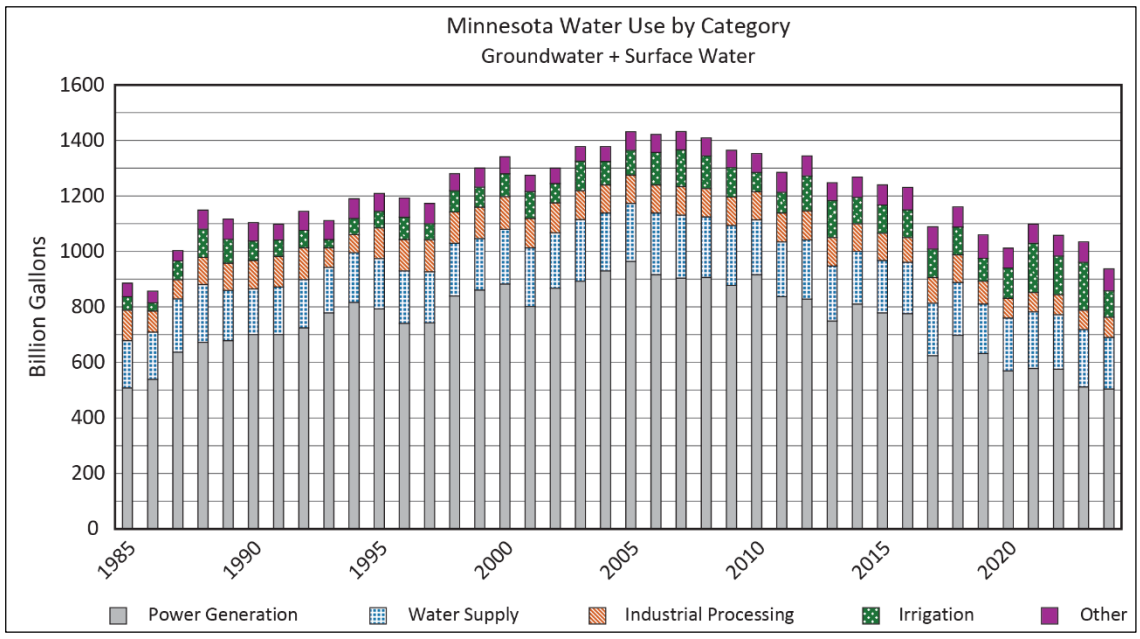


Figure 4. Water use by category[1]

Decreasing water use for generating electricity

The largest portion of Minnesota's water use is from surface water for power generation. Most of the decrease in the state's water is from a decrease in water needed for power plant cooling — a reduction of 48% from 2005 to 2024.

- This reduction occurred even as the overall demand for electricity remained constant.
- Several large power plants converted from coal to natural gas. Natural gas plants require less cooling water. The share of the state's electricity produced by coal-fired power plants declined from 65% to 22% over the period from 2003 to 2023.
- The amount of electrical power generated in Minnesota from renewable sources, including wind, solar, hydropower and biomass, has increased. These sources of electricity mostly do not require cooling water. In 2023, 32% of the state's electricity generation was from renewable sources, mostly from wind turbines. In comparison, only 5% came from renewable resources in 2003.

[1] Water supply is defined as water supplied to municipalities, rural water districts, institutions, and private sources to potable water supply distribution systems, where it is used for drinking water and other uses.

Drought in the early 2020s starts a new trend

Water use for non-power generation declined from 2007 through 2020. This trend abruptly stopped as drought conditions during the summer months of 2021 to 2023 caused increased demand from water suppliers and irrigators. Both water use categories show rising and falling trends based on precipitation patterns. Water supply use increased by 10% and irrigation use increased by nearly 80% over a short time. In the summer of 2024, the state experienced a sharp reversal from the 2021 to 2023 period, with a 100-billion-gallon reduction of water use, also attributable to lower irrigation and water supply use demands.

Increasing groundwater use

Water use from surface water sources declined over the past five years. That reduction was mainly in the power generation and industrial processing categories. Minnesotans get 25% of their drinking water from surface water sources via public water supply systems. Of all the water supplied by these systems, 63% is for residential customers. The remainder is for various non-residential purposes.

While the overall use of surface water has gone down, short-term use of groundwater has increased. From 2014 to 2020, total groundwater use remained steady. On average, **statewide groundwater use increased by one-third** during the 2021 to 2023 drought period, and 2021 was the first year that groundwater use for irrigation surpassed its use for public water supply (Figure 5). In 2024, groundwater use returned to the former three-year average.

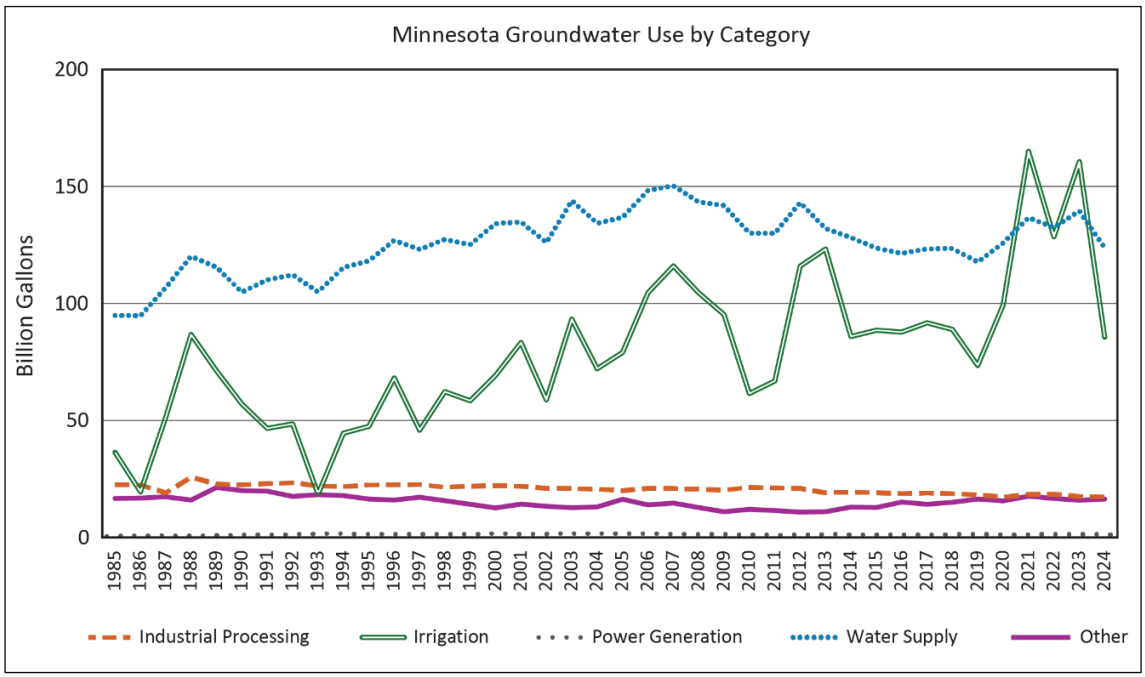


Figure 5. Groundwater use by permit category.

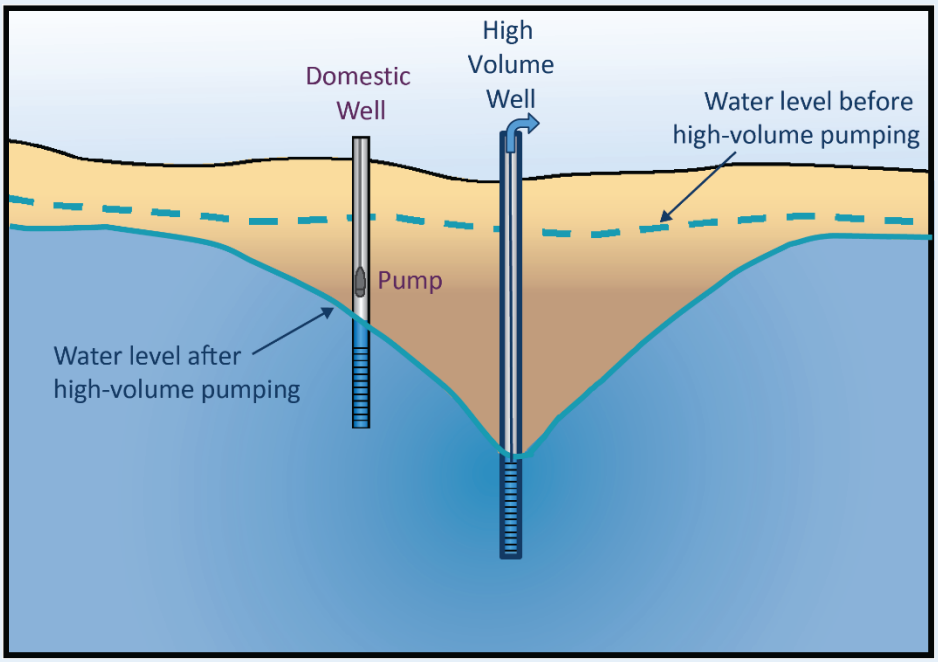
Leadership in per capita water use

In 2023, 83% of reporting water suppliers had a residential water use of 75 gallons per capita per day (GPCD) or less. Conversely, in 2018, 92% of water suppliers who voluntarily reported used 75-gallon GPCD or less. The increase in residential per capita water use from 2018 to 2023 is likely because the summer of 2023 was extremely dry, leading to higher water use (such as for lawn irrigation) than in 2018. Many cities use two to three times more water in the summer than in the winter, mostly for outdoor water use, such as lawn irrigation.

Well interferences

Since 2020, agricultural irrigation using groundwater has increased sharply, due to variable precipitation patterns. With more precipitation coming in extreme events, with long dry stretches in between, more farmers have turned to groundwater for irrigation needs. One consequence of increased groundwater irrigation has been an increase in well interferences or situations where domestic wells, which have the highest water allocation priority, are no longer able to reach the water table due to drawdown from a high-volume well (often an irrigation well). The DNR paid out approximately $210,000 from a drought recovery fund to remedy interferences that happened during the 2021 drought. Between 2021 and 2023, the DNR received more than 200 verbal complaints of well interference, with almost half requiring investigation or settlement.

Additionally, many of these complaints were driven by high outdoor water use within a municipal supply system. These continuing trends highlight the importance of water conservation and demand reduction for water uses for appropriations permit holders, municipal water customers and domestic well owners alike.



High-capacity wells, like those commonly used for irrigation, industrial and municipal use, can draw large volumes of water from deeper in the water table. As levels drop below the pumps in domestic wells, it can prevent those wells from drawing water for household use.

Status of Minnesota's streams

When it rains or when snow melts, some of that water infiltrates into the groundwater system, but most is stored in lakes or wetlands or becomes flow in streams. When precipitation is high or low, streams and rivers tend to respond quickly. From 2020 to 2024, streamflow varied widely across both time and location. On average, flows were normal to above normal compared to historical records. There were, however, significant periods of flooding as well as prolonged low flows that led to the suspension of surface water appropriation permits.

Stream flow extremes are important, so hydrologists use a metric called Q90 to assess times of low stream flow. The Q90 is the level of flow in a stream at which, over the period of record for that stream, the flow is above that level 90% of the time. During water years 2020 to 2024, stream flow was at or below the Q90 at more gages, and for longer time periods compared to water years 2015 to 2019, because of periods of extensive drought.

- For water years 2015 to 2019, 30 gages were at or below Q90 threshold for more than one day. Collectively, gages statewide were at or below their respective Q90 threshold for 1,924 days during this period.
- During water years 2020 to 2024, 60 gages were at or below Q90 threshold for more than one day. Collectively, gages statewide were below the designated Q90 for 6,754 days during water years 2020 to 2024.

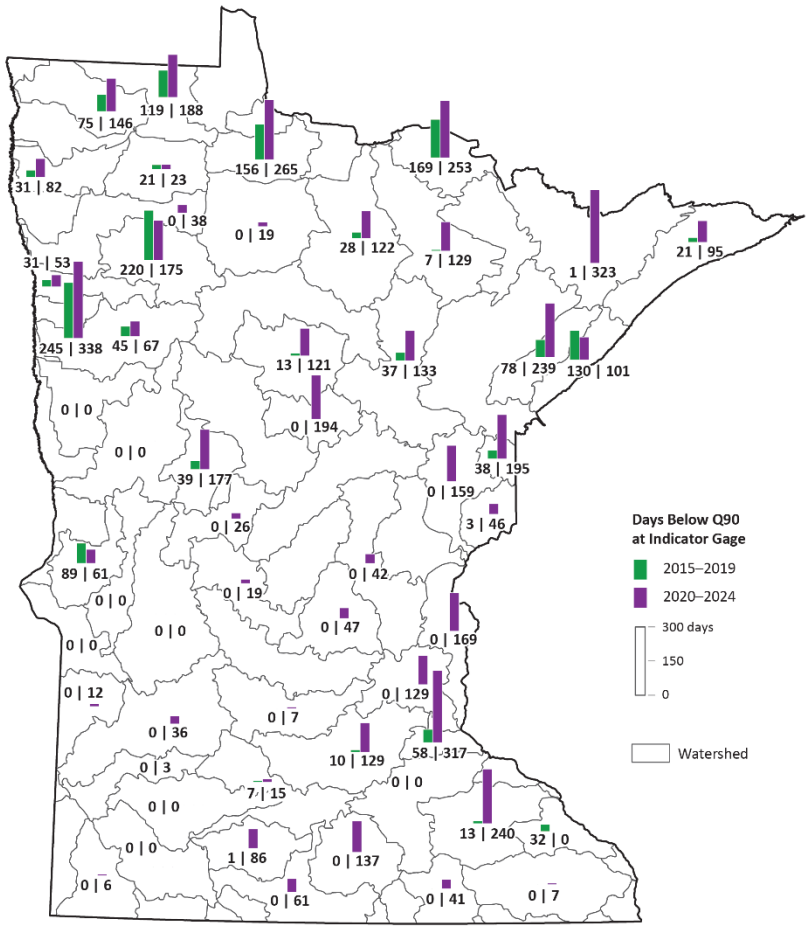


Figure 6. Days below Q90 for each indicator gage. The recent five-year period is in purple and depicts drought years, and the prior five-year period is in green, depicting wetter years.

When stream flow at designated gages falls below the Q90, the DNR is required to curtail surface water appropriation in those watersheds. From 2021 through 2024, the DNR temporarily suspended 454 surface water appropriation permits to protect other water users, instream flows and downstream supplies. The permit use types suspended during this time were:

- 45% agricultural crop irrigation
- 13% golf course irrigation
- 12% wild rice irrigation
- 3% construction non-dewatering
- Less than 3% of a variety of use types

Most of these permits were suspended in 2021 and 2023 during extensive, long-duration drought conditions throughout the growing season.

Status of Minnesota's lakes

Lakes hold a special place in Minnesota's history, culture, and identity. They provide recreational opportunities, support a thriving tourism industry, and help modulate the impacts of high and low precipitation. Lakes are also important ecosystems that support fish and wildlife. They are arguably the most visible and valued aspects of Minnesota's water resources — it's right there on our license plates.

One critical ecosystem service of lakes is their ability to slow down and store water. We benefit from lakes storing water, trapping sediment and slowing runoff. Water levels in lakes are the difference between water coming in, such as precipitation or inflow from streams and groundwater, and water leaving, such as evaporation, human use, or outflow to streams and groundwater. Most lakes naturally experience variability in water levels. **A statewide characterization of lake levels over the last five years highlights the ability for lakes to serve as storage over periods of drought and deficits in precipitation** (Figure 7).

The most recent five-year averages (2021 to 2024) of water levels from lakes with sufficient data were compared to the average water levels from the same lake over the past 30 years. Over 90% of the 464 lakes in the analysis had the recent average water levels that were within 0.5 feet higher or lower than the 30-year average at that lake. This is a good indication that lake levels tend to center around their average water levels, even with periods of increased drought. Dry conditions and drought were much more common from 2020 to 2024 than in recent decades, and yet only 14 of the 464 lakes had recent average water levels that were more than 0.5 feet below their 30-year average. In fact, 25 lakes exceeded their 30-year record by 0.5 feet or more (Figure 7). Large fluctuations can be observed during prolonged drought, but even then, levels appear to recover to the average level with time.

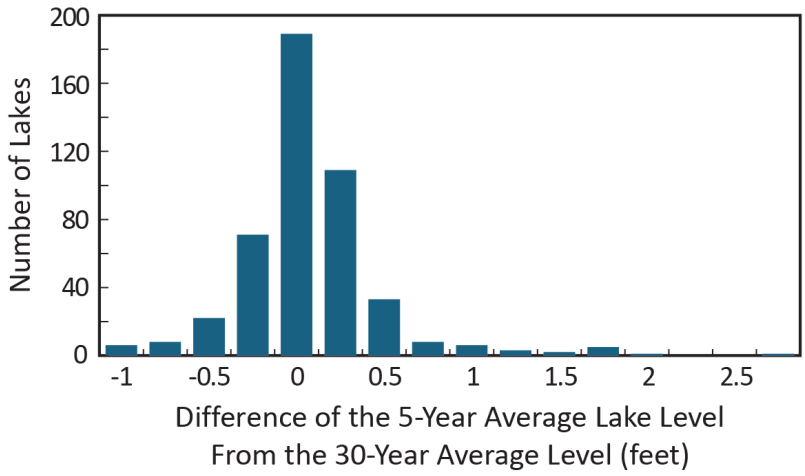


Figure 7. The difference in the 2021 to 2024 average lake level from the 30-year average lake level at 464 Minnesota lakes.

Each lake has unique characteristics that can impact water levels. Some lakes annually fluctuate 0.5 feet or more in any given year, while other lakes don't fluctuate much at all.

Lakes with the most variation in levels seem to be congregated in the eastern Twin Cities metropolitan area (Figure 8). These lakes had the greatest fluctuation in water levels over the 30-year period of analysis.

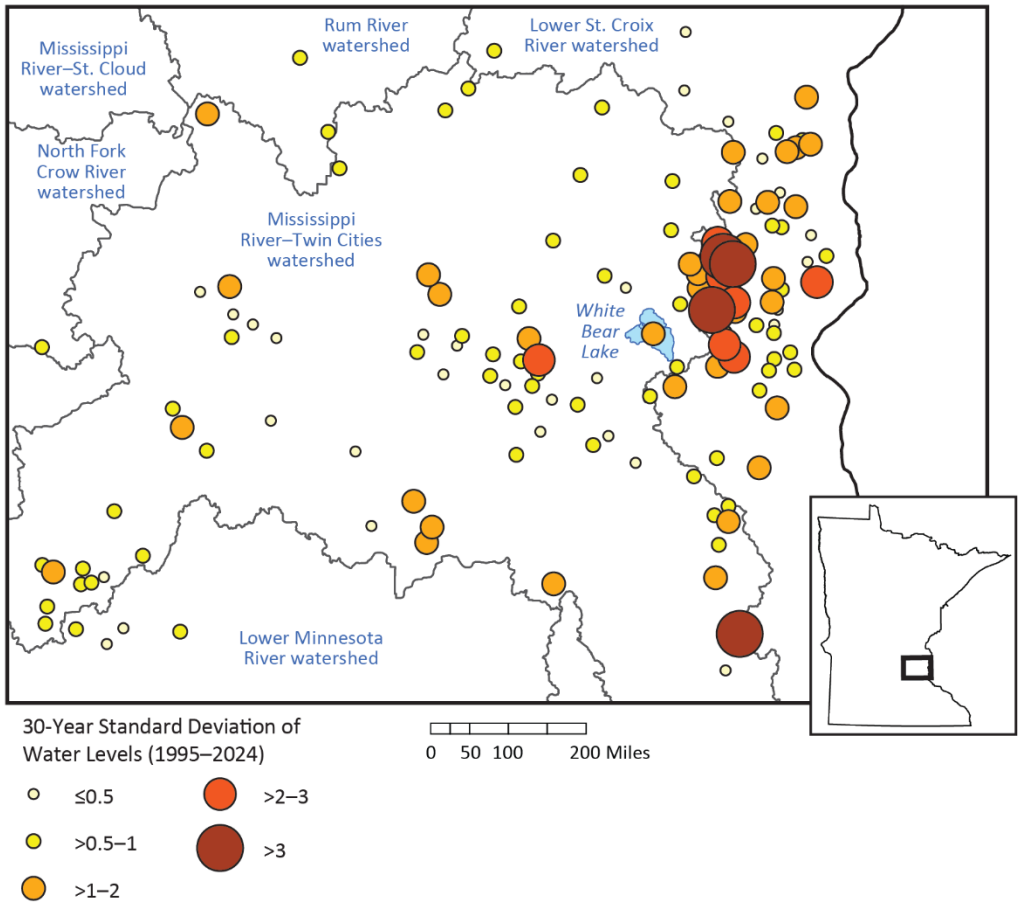


Figure 8. The location of lake level records that have large standard deviations of two or more feet over the 30-year period of analysis.

White Bear Lake (Ramsey and Washington counties)

From 2009 to 2014, White Bear Lake went through a period of low water levels that garnered significant public and political attention.

Consequently, in 2016, the DNR established a protective elevation based on recreational use (922 feet above mean sea level). Hydrological models indicated that White Bear Lake water levels naturally fluctuated but would likely have been higher during the low water years with reduced groundwater pumping. However, the groundwater use did not appear to harm the White Bear Lake ecosystem. For example, water level fluctuations and associated low water levels are essential for a healthy emergent plant community in the lake, which provides valuable fish habitat.

For those water appropriations that are likely to influence White Bear Lake water levels, the DNR may modify the permits to incorporate the protective elevation. Permit modifications might include implementing use restrictions, such as lawn watering, to promote water conservation.

White Bear Lake's low water levels in autumn 2014.

High precipitation contributes to higher lake water levels, and severe droughts reduce lake water levels as inlet flows and groundwater levels decrease. In the last 60 years, the largest changes in lake water levels for most lakes occurred when high precipitation years were quickly followed by a severe drought year. Three periods stand out for large, quick lake water level fluctuations: 1975-1977, 1986-1988 and 2019-2021 (Figure 9).

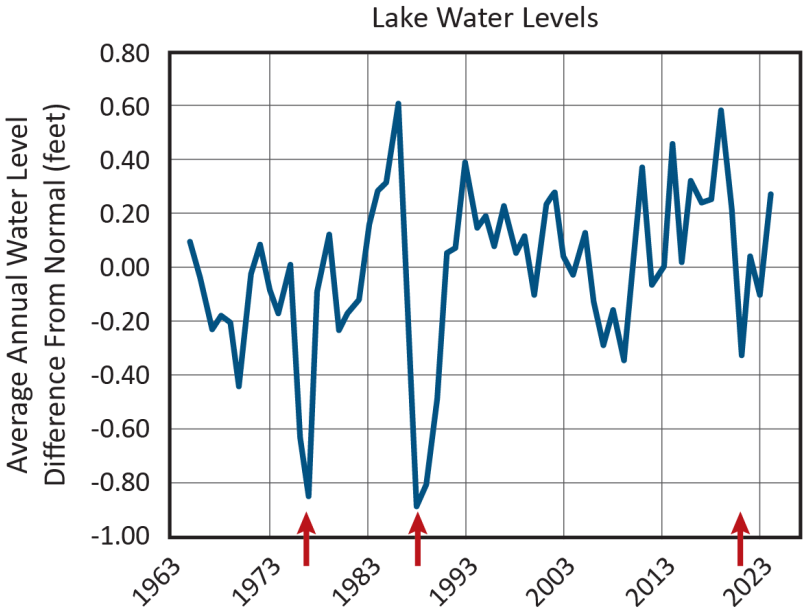


Figure 9. The average difference from normal lake water levels, with red arrows highlighting 1975-1977, 1986-1988 and 2019-2021.

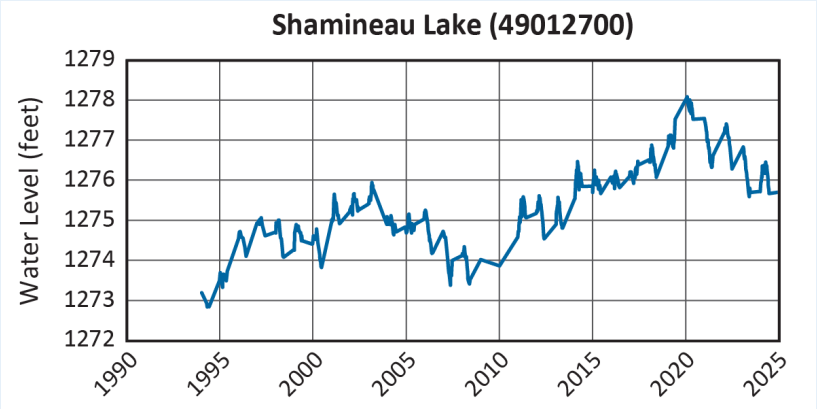
Lakes are not only culturally important, but they are also literally in many Minnesotans' backyards, and fluctuations can have significant economic impacts. Some lake level fluctuation is expected and normal — in fact, occasional lower lake levels promote healthy aquatic plant communities and clearer water. Some additional human-driven changes, such as groundwater pumping, can affect individual lake water levels, but these are not isolated from both normal fluctuations and changing climatic precipitation drivers.

Minnesotans can expect lake levels to continue fluctuating, and the impacts will vary by year and by lake. Predicting how much each lake will fluctuate is difficult, but we expect that lake levels will fluctuate even more than in the past as the climate changes. Lake users, lakeshore property owners and infrastructure managers should expect lake levels to fluctuate to higher highs and lower lows than in the past.

Shamineau Lake (Morrison County)

Human development along lakeshores leads to increased public expectations for managing lake levels to a very narrow range. In most cases, water resource managers have limited ability to control lake levels.

A good example of the challenges of managing lake levels is Shamineau Lake in Morrison County. Shamineau Lake experienced high water levels in 2020 (below), due to higher groundwater levels in the area after years of high precipitation. The lake has no outlet, and the lake level rose significantly, resulting in substantial property damage.



Water levels at Shamineau Lake.

Little Rock Lake (Benton County)

An example of using a drawdown to improve fish and wildlife habitat is Little Rock Lake in Benton County. For more than 100 years, since the Sartell Dam was built, Little Rock Lake water levels were not allowed to fluctuate naturally, and the lake was prone to harmful algal blooms.

In 2019, a three-foot drawdown was initiated for six weeks to promote germination of emergent aquatic plants, and lakeshore property owners planted aquatic plants to accelerate the restoration of a healthy aquatic plant community.

By 2021, water clarity improved slightly, more aquatic vegetation was found growing in the lake, and wildlife frequented new areas. Initial results were positive, yet the efficacy and duration of benefits from lake drawdowns vary by lake.

Many lakes have naturally fluctuating water levels, and their aquatic plants have evolved with large water level fluctuations. For example, bulrush protects shorelines from erosion by buffering waves and stabilizing sediments. It also provides vital aquatic habitat for fish and wildlife. However, bulrush requires periodic, large fluctuations in water levels, including long wet periods followed by long dry periods. Similarly, lowering the lake level of an impounded lake can improve water clarity and habitat for fish and migratory birds.

Clockwise from top left: A significant algae bloom on Little Rock Lake; property owners planting aquatic plants during the down-down period; improved water clarity and wildlife are visible in restored areas.

Status of Minnesota's wetlands

Minnesota's wetlands perform many crucial functions. They store water from snowmelt and rain, thereby reducing flooding that can cause erosion, and provide habitat for wildlife. Wetland plants take up nutrients, which improves water quality in downstream lakes and rivers, store carbon and provide food for wildlife. Some wetlands, such as calcareous fens, host globally and locally rare plants and receive special protection in Minnesota.

Minnesota has 12.2 million acres of wetlands, second in total acreage among the 48 conterminous states, behind only Florida. However, about half of our state's historic wetlands have been drained or filled for agriculture, housing and other forms of development (Figure 10). Most of the remaining and the least impacted wetlands are concentrated in the northern and northeastern parts of the state. Draining wetlands and straightening the connecting riverways has resulted in a loss of water storage capacity, decreased groundwater recharge and reduced ecological benefits.

Restoration and protection of peatlands (a specific type of continually saturated wetland) has been recognized as a priority, to mitigate climate change through the sequestration and storage of carbon from the atmosphere. The Minnesota Legislature and the U.S. Environmental Protection Agency (EPA) have allocated more than $21.5 million for peatland restoration in Minnesota.

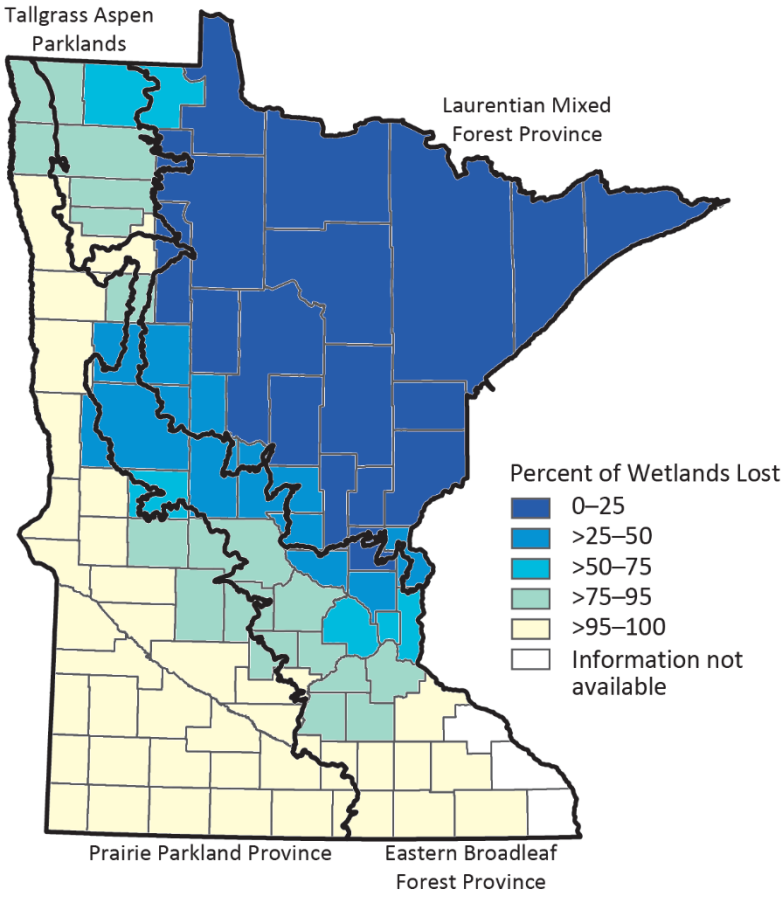


Figure 10. The historical loss of wetlands by county, using data from Anderson and Craig (1984).

Wetland regulation and protection programs have reduced wetland losses, including the passage of the Minnesota Wetland Conservation Act in the early 1990s. The DNR's Wetland Status and Trends Monitoring Program shows that Minnesota had a net gain of approximately 43,000 acres, or 0.3%, of wetland from 2006 through 2020. Preliminary data collected suggest that this trend of net wetland gains has continued, with an additional net gain of 0.1% from 2020 through 2023 (Figure 11). Wetland gains are most common in agricultural areas and can be promoted by restoration programs such as the Outdoor Heritage Fund and Reinvest in Minnesota.

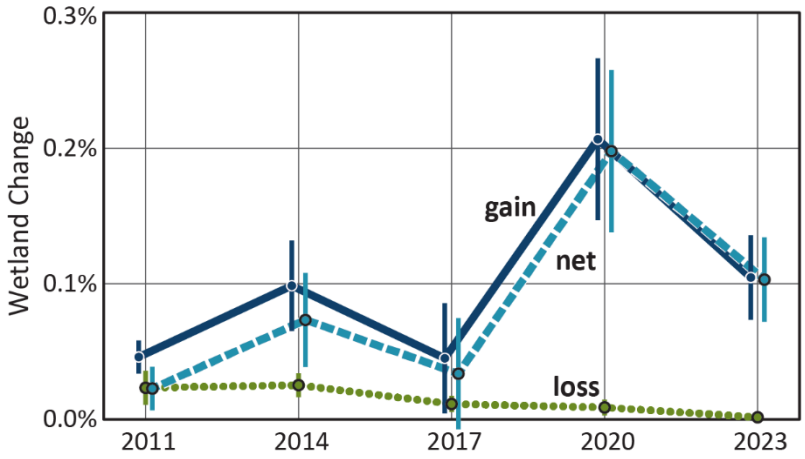


Figure 11. Change[2] in wetland area over time based on the DNR's Wetland Status and Trends Monitoring Program.

Climate directly influences wetland water levels

Wetland water levels are influenced by precipitation, groundwater levels, runoff and evapotranspiration.

Many wetlands are directly connected to groundwater, and increased use of groundwater, especially during droughts, can cause wetland water levels to decline. While water levels in wetlands often fluctuate naturally, groundwater appropriations can reduce water levels further and for longer periods of time. In turn, the wetland plant communities can change, diminishing ecological function.

Unlike streams and lakes, we do not have statewide historical records of wetland water levels that can be used to assess the impacts of extreme weather events and human activities on wetlands in Minnesota. Therefore, the DNR initiated a monitoring network to measure water levels in relatively undisturbed natural wetlands across the state. Monitoring sites were established between 2018 and 2025 and will be in place for 10 years. Data from this monitoring network will be used to characterize water levels for different wetland types across a range of climatic conditions. Funding for this network was provided by the U.S. EPA and the Minnesota Environment and Natural Resources Trust Fund, as recommended by the Legislative-Citizen Commission on Minnesota Resources.

[2] Changes are categorized as gain, loss, or net (difference between gain and loss). Wetland change is expressed as a percentage of the previous monitoring cycle's total wetland area, and the year is the final year in each monitoring cycle. Points represent statewide estimates, and error bars represent 95% confidence intervals. Points and error bars are offset from one another at each year for visibility.

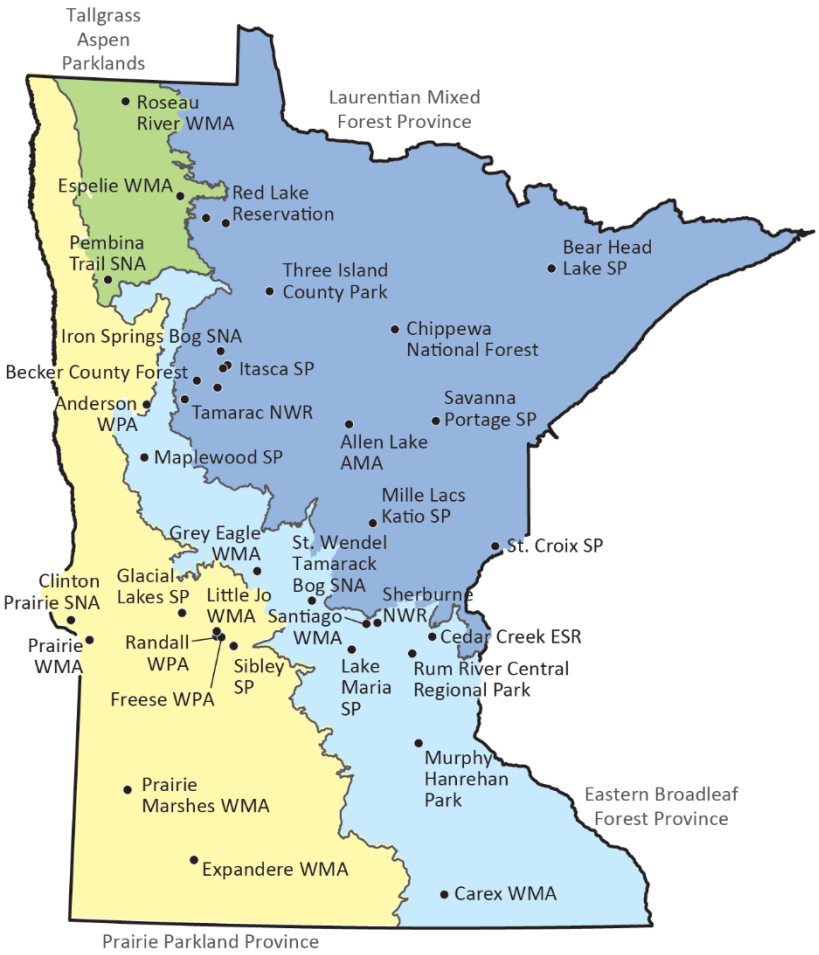


Figure 12. A map of locations with wetland water level monitoring sites. The full network will include 60 sites, spanning a range of geographies and wetland types.

Status of Minnesota's groundwater

Approximately three out of every four Minnesotans rely on groundwater for their drinking water. Minnesota's aquifers also support agriculture, industry, and the natural resources that are vital to Minnesota's quality of life, such as streams, wetlands and lakes. Our aquifers recharge by the percolation of precipitation through the soil. Some aquifers receive precipitation readily and can recharge quickly. Other aquifers are buried deep in the ground and can take years or decades to recharge.

The DNR maintains a statewide network of approximately 1,250 observation wells to monitor our hidden groundwater resource. We evaluated trends at 374 wells, where groundwater levels were measured from 2005 to 2024. Statewide, 5.3% of these observation wells showed downward trends over the period.

Of those 374 wells, 284 were also evaluated for the period from 2000 to 2019. By comparing how trends changed in each well from one period to the next, it is possible to observe how water level trends have changed. Nine wells changed from a stable trend to a downward trend, and 42 wells changed from an upward trend to a stable trend. Multiple episodes of drought over the last five years are likely the cause of the change in trend direction.

There are differences in annual minimum groundwater-level trends across the six groundwater provinces (Figure 13):

- In the metro province, all but one of the observation wells showed an upward or stable trend over the past 20 years. The continued focus on water conservation by large water users contributed to stabilizing groundwater use rates. Wet climatic conditions during the first 20 years of the century also contributed to upward groundwater trends.
- In the central province, 4.7% of observation wells are trending downward, representing a slight decrease from the previously recorded 6%.
- In the western province, 7.5% of wells are trending downward.
- In the south-central province, 15.4% of wells exhibit a downward trend.
- In the northeast and southeast portions of Minnesota, the observation well network is currently too sparse to draw conclusions about the overall state of the aquifers in those areas.

Downward trends in groundwater levels may result from a variety of influences, including extended periods of reduced precipitation, increased reliance on groundwater sources, and alterations in land use or recharge rates. Wells showing declining annual minimum levels might reflect intensified local groundwater consumption during the analysis period. If extraction rates stabilize, associated aquifer level declines could reach equilibrium.

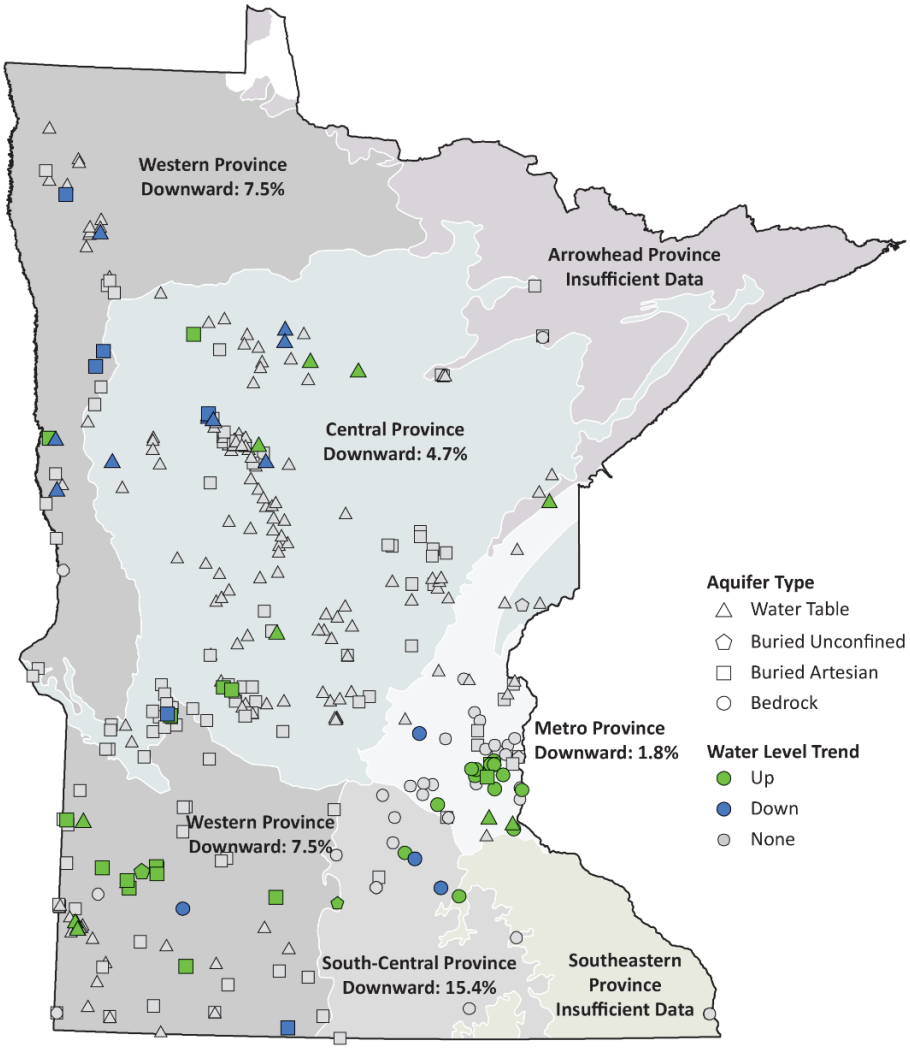


Figure 13. A map of Minnesota's groundwater provinces and their water level trends.

Declining Red River Watershed groundwater levels

In the Red River watershed in northwest Minnesota, 16% of wells have declining groundwater levels, compared to 3.9% of wells in the rest of the state.

Decreasing groundwater levels in northwest Minnesota are likely due to a combination of factors. The aquifers in the western groundwater province are small and usually recharge very slowly. It is also likely that, as the climate of northern Minnesota is warming more rapidly than the rest of the state, commodity crops are being grown that could not have been grown decades ago, resulting in increased groundwater use for crop irrigation.

Groundwater use in the Red River Valley of Minnesota has increased from around 5 billion gallons per year in the late 1980s to 15 to 20 billion in 2021 to 2023. Because many parts of the Red River watershed do not have aquifers, there is high demand placed on the scarce aquifers that do exist.

The lines visible on the rocks along the Red Lake River highlight decreased water levels in recent drought years; groundwater levels, which primarily recharge through precipitation, have also been impacted.

Water law changes: 2020 to 2025

The DNR plays an important role in supporting sustainable water use through its permit programs, data collection and analysis activities, law enforcement responsibilities, education, and technical assistance services. The DNR and other agencies in the executive branch have adopted a three-pronged approach to sustainable water resource management. This approach involves mapping, monitoring and managing water resources adaptively, over time. Since the previous Water Availability and Assessment Report five years ago, the DNR's approach to water management has continued to evolve (see Appendix A).

Thus far, this report has provided data and information on water related to our economy, communities, landscapes, atmosphere and geology. This section of the report describes some of the drivers surrounding policy changes made to Minnesota's water laws since the last report.

2021

A Minnesota-based company proposed to extract 500 million gallons per year of groundwater from Dakota County, Minnesota and transport it via railcar to arid states in the U.S. Southwest. This proposal was the first of its kind in the state, and it faced strong objections due to concerns about depleting Minnesota's water resources. It also sparked discussions surrounding state and interstate water rights. The source of the proposed water appropriation was the Mt. Simon–Hinckley aquifer, a significant source of drinking water in the Twin Cities metropolitan area.

The legislature passed changes in water laws to provide additional protection for the Mt. Simon–Hinckley aquifer and limit the ability to move water outside of the state, while still allowing a certain amount of movement to support regional water systems, such as rural water supply systems.

> **Note**: When the protections for the Mt. Simon aquifer were expanded to the extent of the aquifer beyond the seven-county metropolitan area, it had an unexpected impact of eliminating non-potable uses for those who don't have other options. The DNR has been working with legislators to find a solution that provides some opportunity for accessing water while also protecting the aquifer from non-essential uses.

The statutory changes signed into law in 2021 are listed below:

Minnesota Statute 103G.271: Appropriations and Use of Waters

Subdivision 4a. Mt. Simon-Hinckley aquifer. ~~(a)~~ The commissioner may not issue new water-use permits that will appropriate water from the Mt. Simon-Hinckley aquifer ~~in a metropolitan county, as defined in section~~ 473.121, subdivision 4~~,~~ unless the appropriation is for potable water use, there are no feasible or practical alternatives to this source, and a water conservation plan is incorporated with the permit. ~~(b) The commissioner shall terminate all permits authorizing appropriation and use of water from the Mt. Simon-Hinckley aquifer for once-through systems in a metropolitan county, as defined in section~~ 473.121, subdivision 4~~, by December 31, 1992.~~

Subdivision 4b. Bulk transport or sale (a) To maintain the supply of drinking water for future generations and except as provided under paragraph (b), the commissioner may not issue a new water-use permit to appropriate water in excess of one million gallons per year for bulk transport or sale of water for consumptive use to a location more than 50 miles from the point of the proposed appropriation.

2023

In 2016, as directed, the DNR published a report to the legislature titled *Definitions and Thresholds for Negative Impacts to Surface Waters*. This report was required by legislation in the 2015 session, seeking clarity about how much water can be diverted and used without harming ecosystems (a statutory requirement). A comprehensive review of scientific literature indicated that the practice of relying on the Q90 as the protection level for low flows was likely causing adverse impacts to ecosystems. The team of scientists ultimately recommended using a maximum percentage of water relative to an index flow that can be removed or diverted to establish protection levels that avoid causing harm or negative impacts to surface water bodies. Between 2016 and 2023, the DNR invested in developing groundwater models and completing fish habitat analyses to apply the percentage of flow approach to parts of Minnesota. Coupled with growing concerns about overusing groundwater, the technical report and analyses helped support the statutory revisions described below. The result is a holistic, systems approach to water resources management that recognizes the groundwater to surface water connections.

Additionally, amidst the second consecutive year of drought in Minnesota, it was becoming clear there were some egregious and repeated violations of water appropriation regulations in the state. The DNR proposed more effective regulatory tools to enforce statutes and revised the Administrative Penalty Order Plan to ensure water users comply with water appropriation laws.

The DNR also proposed increasing the water use permit processing fees for peak water use by municipal water suppliers during the summer months. This was one way to signal the importance of conservation associated with the stresses of high-water use demands in the summer. The additional revenue generated by fees helps support the DNR's water resource programs, provide ongoing and improved technical assistance, and ensure timely permitting and review processes for water permit applications.

The statutory changes signed into law in 2023 are listed below:

Minnesota Statute 103G.005: Definitions

Subdivision 9 b/c. Ecosystem harm. "Ecosystem harm" means to change the biological community and ecology in a manner that results in loss of ecological structure or function.

Subdivision 13a/b. Negative impact to surface waters. "Negative impact to surface waters" means a change in hydrology sufficient to cause aquatic ecosystem harm or alter riparian uses long-term.

Subdivision 15h/i. Sustainable diversion limit. "Sustainable diversion limit" means a maximum amount of water that can be removed directly or indirectly from a surface water body in a defined geographic area on monthly or annual basis without causing a negative impact to the surface water body.

Minnesota Statute 103G.287: Groundwater Appropriations

Subdivision 2. Relationship to surface water resources**.** Groundwater appropriations ~~that will have negative impacts to surface waters are subject to applicable provisions in section 103G.285~~ may be authorized only if they avoid known negative impacts to surface waters. If the commissioner determines that groundwater appropriations are having a negative impact to surface waters, the commissioner may use a sustainable diversion limit or other relevant method, tools, or information to implement measures so that groundwater appropriations do not negatively impact the surface waters.

Subdivision 3. Protecting groundwater supplies**.** The commissioner may establish water appropriation limits to protect groundwater resources. When establishing water appropriation limits to protect groundwater resources, the commissioner must consider the sustainability of the groundwater resource, including the current and projected water levels, cumulative withdrawal rates from the resource on a monthly or annual basis, water quality, whether the use protects ecosystems, and the ability of future generations to meet their own needs. The commissioner may consult with the commissioners of health, agriculture, and the Pollution Control Agency and other state entities when determining the impacts on water quality and quantity.

Minnesota Statute 103G.299: Administrative Penalties

Subdivision 1. Authority to issue administrative penalty orders a) As provided in paragraph (b), the commissioner may issue an order requiring violations to be corrected and administratively assessing monetary penalties for violations of sections 103G.271 and 103G.275, and any rules adopted under those sections.(b) An order under this section may be issued to a person for water appropriation activities without a required permit or for violating the terms of a required permit.(c) The order must be issued as provided in this section and in accordance with the plan prepared under subdivision 12.

Subdivision 2. Amount of penalty; considerations (a) The commissioner may issue orders assessing administrative penalties ~~based on potential for harm and deviation from compliance. For a violation that presents:~~ up to $40,000.

~~(1) a minor potential for harm and deviation from compliance, the penalty will be no more than $1,000;~~
~~(2) a moderate potential for harm and deviation from compliance, the penalty will be no more than $10,000; and~~
~~(3) a severe potential for harm and deviation from compliance, the penalty will be no more than $20,000.~~

Subdivision 5. Penalty Subd. 5. **Penalty.** (a) Except as provided in paragraph (b), if the commissioner determines that the violation has been corrected or appropriate steps have been taken to correct the action, the penalty must be forgiven. (b) For repeated or serious violations, the commissioner may issue an order with a penalty that is not forgiven after the corrective action is taken. The penalty is due ~~by~~ 31 days after the order ~~was~~ is received, unless review of the order under subdivision 6 or 7 ~~has been~~ is sought. (c) Interest at the rate established in section 549.09 begins to accrue on penalties under this subdivision on the 31st day after the order with the penalty ~~was~~ is received.

2024

Public waters are defined in statute and include lakes, wetlands and watercourses of certain sizes and characteristics. The original Public Waters Inventory (PWI) was compiled in the 1980s. This tool is valuable in identifying public waters in Minnesota, but it does not determine whether a waterbody is a public water. A waterbody is a public water if it meets the statutory definition of public waters.

A drainage authority project on Limbo Creek in Renville County, Minnesota initiated a dispute about whether a waterbody needed to be on the PWI to be a public water. An environmental advocacy group petitioned for an Environmental Assessment Worksheet (EAW), arguing the project could have significant environmental effects on the creek. The EAW petition was denied by Renville County, stating that a portion of the creek was not a public water because it was not listed in the inventory. This was appealed and led to a Minnesota Supreme Court ruling that Limbo Creek is indeed a public water despite its omission from the PWI, and the proposed project required an EAW. However, the court ruling did not address the larger question of whether a waterbody needed to be on the PWI to be a public water. The court said that was an issue the Minnesota Legislature needed to clarify.

A 2024 statute revision clarified that public waters are not determined by their inclusion in or exclusion from the PWI. However, because the PWI is such an important tool, the legislature appropriated $1,000,000 from the general fund each year in fiscal years 2025 through 2032 and directed the DNR to update the PWI over the next eight years. The PWI update will provide better water resource protection and a shared understanding for landowners, local governments and the public at large.

The statutory changes signed into law in 2024 are listed below:

Minnesota Statute 103G.201: Public Waters Inventory

(b) The commissioner ~~is authorized to~~ must revise the map of public waters established under Laws 1979, chapter 199, to reclassify those types 3, 4, and 5 wetlands previously identified as public waters wetlands under Laws 1979, chapter 199, as public waters or as wetlands under section 103G.005, subdivision 19. (f) $1,000,000 is appropriated from the general fund each year in fiscal years 2025 through 2032 to the commissioner to update the public water inventory as required in this section. The commissioner must develop and implement a process to update the public water inventory. This paragraph expires June 30, 2032.

2025

Minnesota had just emerged from four consecutive years of drought in various parts of the state and was preparing for the possibility of the fifth. The DNR was closely monitoring water use and potential conflicts during this time. Simultaneously, large water users, such as dairies, sustainable aviation fuel production centers and data centers were proposed or expanding across the state. Smaller-scale data centers have been in Minnesota for many years. However, with the demands for cloud storage and artificial intelligence, nearly a dozen large-scale data centers have been proposed near the Twin Cities metropolitan and surrounding areas. Data centers demand large amounts of energy and water. This

has created controversy in some Minnesota communities. Early coordination is key to managing the effects of data centers on Minnesota's communities and environment.

As Minnesota's economy grows, so does water demand. Demand for groundwater is high in western Minnesota, where the groundwater supply is limited. Not all projects will be able to access the amount of groundwater they want, and water use conflicts are emerging in places where the groundwater supply is inadequate to meet all the proposed needs. As climate extremes lead to unprecedented rates of intensive groundwater use, we are seeing high rates of well interference. In some places, such as the east Twin Cities metropolitan area or Bemidji, groundwater contamination is severely restricting how groundwater can be used. These problems collectively require more analysis and are more complex and time-consuming to permit, which has created an application backlog.

A proposed fee increase was approved to support the changing demands in the DNR's services for permit application review and analysis across the state, including:

- Technical review and analyses of new applications and existing permits.
- Reducing the backlog in technical review and analysis for more complex project proposals.
- Supporting DNR compliance efforts in areas with limited water availability and increasing demands for water resources.
- Improved understanding of aquifers across the state.

The statutory changes signed into law in 2025 are listed below:

Minnesota Statute 103G.265: Water Supply Management

Subdivision 5. Preapplication evaluation of certain water appropriation projects. (a) This subdivision applies to a data center, as defined in section 216B.02, subdivision 11, whose proposed consumptive use exceeds 100,000,000 gallons per year and which requires a permit amendment or a new individual permit. (b) In response to a contact from a data center regarding a project that is likely to be subject to this subdivision, the department may request preapplication information from the data center that is helpful in assisting the department to assess the factors affecting the ability of a water source to meet a project's water use needs at a proposed location.

Minnesota Statute 103G.271: Appropriation and Use of Waters

Subdivision 5b. Large water appropriation projects; permit conditions.

(a) In issuing new or modified water use permits to applicants that meet the definition of a data center, as defined in section 216B.02, subdivision 11, whose proposed new or additional consumptive use exceeds 100,000,000 gallons per year, or for existing permits where the permittee intends to provide more than 100,000,000 gallons of water per year to a data center, the department shall ensure that:

(1) public health, safety, and welfare are adequately protected;
(2) technologies or measures that promote water conservation, the efficient use of water, and watershed health, are reasonably considered, including but not limited to using water efficient fixtures and practices, recycling water before discharging, partnering with local water utilities to use discharged water from the data center, using reclaimed water, installing closed-loop systems, and supporting water restoration and replenishment in local watersheds; and
(3) water use conflicts are addressed as prescribed in Minnesota Rules, part 6115.0740.

(b) The commissioner shall require an applicant to conduct an aquifer test as provided under section 103G.287, if the commissioner determines that the test results are necessary in order to ensure compliance with paragraph (a), clause (1).

Minnesota Statute 103G.271: Appropriation and Use of Waters

Subdivision 6. Water-use permit processing fees (a) Except as described in paragraphs (b) to (g), a water-use permit processing fee must be prescribed by the commissioner in accordance with the schedule of fees in this subdivision for each water-use permit in force at any time during the year. Fees collected under this paragraph are credited to the water management account in the natural resources fund. The schedule is as follows, with the stated fee in each clause applied to the total amount appropriated:

(1) ~~$140~~ $200 for amounts not exceeding 50,000,000 gallons per year;
(2) ~~$3.50~~ $6 per 1,000,000 gallons for amounts greater than 50,000,000 gallons but less than 100,000,000 gallons per year;
(3) ~~$4~~ $7 per 1,000,000 gallons for amounts greater than 100,000,000 gallons but less than 150,000,000 gallons per year;
(4) ~~$4.50~~ $8 per 1,000,000 gallons for amounts greater than 150,000,000 gallons but less than 200,000,000 gallons per year;
(5) ~~$5~~ $9 per 1,000,000 gallons for amounts greater than 200,000,000 gallons but less than 250,000,000 gallons per year;
(6) ~~$5.50~~ $10 per 1,000,000 gallons for amounts greater than 250,000,000 gallons but less than 300,000,000 gallons per year;
(7) ~~$6~~ $11 per 1,000,000 gallons for amounts greater than 300,000,000 gallons but less than 350,000,000 gallons per year;
(8) ~~$6.50~~ $12 per 1,000,000 gallons for amounts greater than 350,000,000 gallons but less than 400,000,000 gallons per year;
(9) ~~$7~~ $13 per 1,000,000 gallons for amounts greater than 400,000,000 gallons but less than 450,000,000 gallons per year;
(10) ~~$7.50~~ $14 per 1,000,000 gallons for amounts greater than 450,000,000 gallons but less than 500,000,000 gallons per year; and
(11) ~~$8~~ $15 per 1,000,000 gallons for amounts greater than 500,000,000 gallons per year.

(b) For once-through cooling systems, a water-use processing fee must be prescribed by the commissioner in accordance with the following schedule of fees for each water-use permit in force at any time during the year:
(1) for nonprofit corporations and school districts, $200 per 1,000,000 gallons; and
(2) for all other users, $420 per 1,000,000 gallons.

(c) The fee is payable based on the amount of water appropriated during the year and~~, except as provided in paragraph (f),~~ the minimum fee is $100.
(d) For water-use processing fees other than once-through cooling systems:
(1) the fee for a city of the first class may not exceed ~~$250,000~~ $325,000 per year;
(2) the fee for other entities for any permitted use may not exceed:
    (i) ~~$60,000~~ $75,000 per year for an entity holding three or fewer permits;
    (ii) ~~$90,000~~ $125,000 per year for an entity holding four or five permits; or
    (iii) ~~$300,000~~ $400,000 per year for an entity holding more than five permits;
(3) the fee for agricultural irrigation may not exceed ~~$750~~ $1,500 per year;

(h) A surcharge of $50 per million gallons in addition to the fee prescribed in paragraph (a) shall be is applied to the volume of water used in each of the months of May, June, July, August, and September that exceeds the volume of water used in January for municipal water use, irrigation of golf courses, and landscape irrigation. The surcharge for municipalities with more than one permit shall be is determined based on the total appropriations from all permits that supply a common distribution system.

Minnesota Statute 103G.301: General Permit; Application Procedures

Subdivision 2: Permit application and notification fees (c) The fee to apply for a permit to appropriate water, in addition to any fee under 142.6 paragraph (b), is ~~$150~~ $600. The application fee for a permit to construct or repair a dam 142.7 that is subject to a dam safety inspection, to work in public waters, or to divert waters for 142.8 mining must be at least $1,200, but not more than $12,000. The fee for a notification to 142.9 request authorization to conduct a project under a general permit is $400, except that the 142.10 fee for a notification to request authorization to appropriate water under a general permit 142.11 is $100.

Conclusion

Minnesota's climate is changing outside of the range of normal variations, and that change is evident on our landscape. Despite the increased precipitation and long-term wetter trends, the state is experiencing multiple intense drought events alongside historical flooding events. In combination, these conditions are creating a highly dynamic and variable landscape in this predominantly wet period. In response, streamflow is increasing, floods are bigger, some lake levels are higher and some wetlands are wetter. We also have more wetlands now than a decade ago — likely due to state and federal programs that protect and restore them. Groundwater levels are generally stable, but there are areas where groundwater levels are falling, resources are overallocated and the groundwater supply is limited. Groundwater use has increased by one-third, largely due to irrigation needs during periods of drought, and the state experienced a record number of well interferences between 2021 and 2023. Water suppliers and the energy sector have improved water use efficiency and conservation over the past decade and, consequently, Minnesota's total water use has declined, even as our population has grown.

While some of this is unpredictable and out of Minnesotans' control, below are recommendations from DNR water experts to help communities adapt and remain resilient, considering the observed trends:

- Despite the wet regime the state is currently experiencing, Minnesotans should expect and plan for drought.
- Improve water conservation and water use efficiencies wherever possible.
- Expect natural lake level fluctuations and plan for water level increases, despite potential swings in lake levels within a season.
- Engage with your community and with surrounding communities to advance sustainable water resources management.
- Given the uneven distribution and demand for water, DNR encourages project proposers and municipalities to consider seasonal and long-term water needs very early in their planning process, and to consult with their area hydrologist as early as possible.

The DNR is committed to working with other regulators and water users to enhance resiliency and sustainability in Minnesota in the face of these trends and anticipated future changes.

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Appendix A

The DNR's role in supporting water use

The Water Availability and Assessment Report has provided data and information on water in relation to our economy, communities, landscapes, atmosphere and geology. This appendix outlines how the DNR continues to support the development of sustainable water use by individuals, businesses and communities.

Implementation of Minnesota's water laws

DNR efforts are mandated under a variety of statutes. Here are highlights of some of the most important statutes and rules that govern DNR work around water availability, as well as how the DNR has applied those statutes to programs:

Minnesota Statute 103A.201: Regulatory Policy

- To conserve and use water resources of the state in the best interests of its people, and to promote the public health, safety, and welfare, it is the policy of the state to regulate Minnesota's public waters, subject to existing rights, and control the appropriation and use of waters of the state.

Minnesota Statute 103A.43: Water Assessments and Reports

- The DNR shall provide an assessment and analysis of the quantity of surface and groundwater and the availability of water to meet the state's needs.

Minnesota Statute 103G.101: Water Conservation Program

- The commissioner shall develop a water resources conservation program for the state.
- The program must include conservation, allocation, and development of waters of the state for the best interests of the people.
- The commissioner must be guided by the program in issuing permits for the use and appropriation of the waters of the state.

Minnesota Statute 103G.255: Allocating and Controlling Waters of the State

- Directs the commissioner to administer the use, allocation, and control of waters of the state; establish, maintain, and control lake levels and water storage reservoirs; and determine ordinary high-water level of waters of the state.

Minnesota Statute 103G.261: Water Allocation Priorities

- Directs the commissioner to adopt rules for allocation of water based on six priorities for the consumptive appropriation and use of water. Outlines where and when use of surface water should be encouraged or discouraged.

Minnesota Statute 103G.265: Water Supply Management

- Requires the DNR to manage water resources to assure an adequate supply to meet long-range seasonal requirements for domestic, municipal, industrial, agricultural, fish and wildlife, recreational, power, navigation, and quality control purposes. This law also requires DNR approval for large volume water diversions to places out of state and diversion from the Great Lakes.

Minnesota Statute 103G.271: Surface Water Appropriations

- Limits appropriations from the Mt. Simon–Hinckley aquifer to potable water use, unless there are no feasible or practical alternatives, and a water conservation plan is incorporated.
- Bulk transport or sale describes limitations on shipping or distributing bulk water to a location more than 50 miles from the point of appropriation. Public water suppliers, rural water suppliers, or tribal nations may distribute water up to 100 miles from the point of the appropriation.

Minnesota Statute 103G.285: Surface Water Appropriations

- Limits appropriation from watercourses during periods of low flow, requires protective elevations for lakes, restricts use of trout streams, and requires contingency plans.

Minnesota Statute 103G.287: Groundwater Appropriations

- Identifies information needed an evaluation to be done for groundwater appropriation permits and allows for the designation of groundwater management areas. Also describes sustainability criteria: The commissioner may issue water-use permits for appropriation from groundwater only if the commissioner determines 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 Statute 103G.291: Public Water Supply Plans; Appropriations During Deficiency

- Every public water supplier serving more than 1,000 people must submit a water supply plan to the commissioner that must address projected demands, adequacy of the water supply system and planned improvements, existing and future water sources, natural resource impacts or limitations, emergency preparedness, water conservation, supply and demand reduction measures, and allocation priorities. Plans must be updated every 10 years.

Minnesota Statute 103G.299: Administrative Penalties

- This section describes the penalties that could be applied to a landowner that appropriates water without a permit or violates the terms and conditions of an existing permit. The maximum penalty amount was increased to $40,000 following language changes during the 2023 legislative session. Additional revisions related to these changes in 103G.299 include 103G.134 (Orders and Investigations).

Minnesota Rule: Chapter 6115, Public Water Resources and Water Appropriation and Use

- These rules exist to provide for the orderly and consistent review of permit applications in order to conserve and utilize the water resources of the state in the best interest of its people.
- These rules set forth minimum standards and criteria pertaining to the regulation, conservation, and allocation of the water resources of the state, including the review, issuance, and denial of public water work permit applications and water appropriation applications and the modification, suspension, or termination of existing permits.

Water appropriation permitting

The DNR is required to administer a permit system to manage the use of groundwater and surface water throughout the state, and to conserve these same waters for everyone to enjoy. In times of shortage, this may include restricting permitted water use, consistent with legislatively established priorities. A water appropriation (use) permit is required for anyone who uses more than 10,000 gallons of water per day or 1 million gallons of water per year. The number of water use permits for irrigation of agricultural crops represents 63% of all permits issued. Today, the DNR manages more than 10,000 water use permits throughout the state. All water users must submit annual reports of their monthly water use to the DNR. These reports assist the DNR in managing the resource, especially during times of drought.

The DNR has established three groundwater management areas (GWMAs) in locations with heavy use, to ensure that groundwater resources remain sustainable: the North and East Metro GWMA in 2015, the Bonanza Valley GWMA in 2016 and the Straight River GWMA in 2017. The DNR followed guidance contained in Minnesota Statute (Minn. Stat.) 103G.287 in creating these GWMAs. DNR staff, in collaboration with local stakeholders in those areas, have developed implementation plans to improve the management of groundwater for all users and for the natural resources and fish and wildlife habitat that depend on that same water.

Over the past several years, drought conditions have stressed aquifers and surface waters, and in some situations have limited the availability of water for domestic well owners. Minn. Stat. 103G.261 outlines the allocation priorities in the state, and domestic supplies are listed as the highest priority in times of shortages. Additionally, the DNR is required to curtail surface water appropriation when flows and levels are below established minimum thresholds. Minn. Stat. 103G.285, subd. 2, describes how the DNR may limit appropriation from watercourses during low flows. From 2021 through 2024, the DNR suspended 454 surface water appropriation permits to protect other water users, instream flows and downstream supplies. Most of those permits were suspended in 2021 and 2023, as those years experienced extensive, long-duration drought conditions during the growing seasons.

Water permitting and reporting system

The DNR uses the online MNDNR Permitting and Reporting System (MPARS) to manage a variety of water permits. This system allows the public to apply for six DNR permit types (water appropriation, public waters work, dam safety, water aeration, aquatic plant management, and invasive aquatic plant management) online, as well as request changes to existing permits, pay permit-related fees, report water use and communicate with DNR staff. DNR staff use the system to record the decision-making process and issue water appropriation permits. More than 10,000 customers, DNR water regulations staff and interagency partners statewide use this system. Using MPARS, the DNR processes an average of 1,100 water appropriation permits annually and receives 10,700 water use reports. This system helps streamline much of the administrative work that comes with water regulatory programs, allowing DNR employees to devote more time to assisting applicants, gathering the information needed to inform decisions, and related work.

The protection of surface waters

The DNR protects public waters, which include most lakes and many wetlands and watercourses, under the statutory authority of Minn. Stat. 103G.245. Alterations to public waters, such as fill placement, excavation, water level controls, restoration, culvert and structure placement, and mining, are regulated through the DNR public waters permitting program. Regulating activities on other public waters, such as wetlands and watercourses upstream of lakes in the watershed, has profound positive impacts on the lakes downstream. Activities that are categorically harmful or unreasonable are

prohibited, while most other activities are conditionally allowed to some degree. This program seeks to balance the protection and use of the water resource.

Shoreland protection

With Minnesota experiencing more intense precipitation and warming waters, risks are increasing for greater shoreline erosion and accelerated algae growth. The risks increase for lakes with reduced naturally vegetated shorelines. Natural vegetation stabilizes shorelines, reducing sediment-laden nutrients from entering surface waters, and it also filters out nutrients washing off of lawns before they enter the water. Nutrients are food for algae, and algae grow faster as the waters warm. In response to eroding shorelines, many property owners are installing excessive riprap. These actions can have negative impacts, including displacing natural vegetation that is important for fish and wildlife habitat and nutrient uptake. The DNR administers the state shoreland program in cooperation with local governments that implement the state shoreland rules through local zoning. The DNR provides technical support and training services to local governments to help staff, planning commissions and boards of adjustments make decisions consistent with the state's shoreland laws.

Engagement with water users

Active engagement with water suppliers and users supports practical planning and conservation efforts. Highlights of our engagement in these areas are listed below.

Water supply planning

Planning for future water use helps avoid surprises for suppliers, customers and other appropriators. Minn. Stat. 103G.291 requires all water suppliers serving more than 1,000 people and all communities within the seven-county metropolitan area with a municipal water supply system to submit a water supply plan to the DNR for approval every 10 years. These plans address topics including water demand projections, the adequacy of their existing and planned water supply systems and water sources, water conservation, and demand reduction measures.

The DNR is about to launch the latest generation of water supply planning, working with the Metropolitan Council to support suppliers within the seven-county metropolitan area and directly with water suppliers across the rest of the state ahead of plan submission to help flag concerns with water availability, potential impacts to natural resources, and opportunities for conservation. A major aspect of water supply planning in this cycle will focus on the need to factor water conservation into the strategy to meet demand, rather than as a separate commitment. The DNR is preparing resources to provide suppliers ahead of conversations to reduce the burden on suppliers and ensure they have the best information to make these decisions.

Recent droughts and associated increases in water use have highlighted the importance of water supply planning in preparing contingencies and preventing domestic well interferences. As the DNR improves the connection between water supply planning and future permit amendment requests, communication with suppliers will be key to developing successful processes.

Local water utilities and communities are becoming leaders in water conservation strategies, to ensure protection of their own local and regional supplies. We can expect additional water conservation efforts and innovations in the future, including expanded use of smart meters and associated behavior change reductions, such as those in the electrical utility field.

Water conservation

Water conservation actions.

Reduce

- Withdrawals from any water supply sources
- Consumptive water uses
- The loss or waste of water

Increase

- The efficiency of water use
- Recycling and reuse of water

The DNR integrates water conservation into all aspects of water regulations and permitting through Minn. Stat. 103G.101, including statewide water conservation education and outreach.

Since 2017, Minnesota has used the Minnesota Water Conservation Reporting System via ESP Water, a software platform that allows water users to track their water losses and conservation efforts. The Minnesota Water Conservation Reporting System provides municipal water suppliers with a way to compare their water losses and conservation work with other suppliers and from year to year. The DNR continues working with suppliers to improve data collection and the value that the reporting provides. Additionally, the DNR can get a high-level view across the state of where there are challenges or opportunities in water conservation activities and use this information to improve recommendations and policies.

Water resources science in decision-making

The following sections describe the DNR efforts that contribute to a better understanding of water availability in Minnesota through collecting, analyzing and applying water resource data to our decisions, and making those data available for others to use.

Climatology

The State Climatology Office (SCO) is part of the DNR. The SCO collects, maintains, analyzes and shares climate information for the benefit of the state's citizens, communities, organizations and units of government at all scales. With an extensive website, many custom tools and through partnerships with local, state and federal entities, the SCO provides public access to an array of raw, summarized, mapped and narrative climate data and information. DNR climatologists give around 80 presentations and more than 100 media interviews annually, lending expertise on floods, drought, the changing climate and recent weather extremes to reports, project teams and other work groups.

Minnesota has more volunteer precipitation observers than any other state. The SCO has worked with local soil and water conservation districts to manage a single network for more than 50 years, with more than 1,000 daily observers. From 2020 through 2024, the DNR partnered with the National Weather Service to recruit three times more new precipitation observers into the nationwide Community Collaborative Rain, Hail and Snow Network, referred to as CoCoRaHS, than any other state, accounting for 25% of all new volunteer observers recruited nationally.

Minnesota's large population of volunteer rain and snow observers gives DNR climatologists unmatched capabilities to analyze the state's often extreme hydroclimate and produce data products, including weekly maps of precipitation and snow depth, that are not possible elsewhere.

In addition to maintaining and expanding volunteer precipitation observer networks, from 2020 to 2024, the DNR also upgraded each of its 40 real-time weather monitoring stations. Additionally, DNR climatologists advised the development and expansion of an agricultural weather network overseen by the Minnesota Department of Agriculture (MDA), and a local high-density mesonet, a network of automated weather and environmental stations operated by Hennepin County Emergency Management.

Outside the SCO, the DNR also has experts in climate impacts, resilience and mitigation in every division, and has an internal climate team that provides guidance, coordination and leadership for climate strategies across the agency. The DNR also advises and collaborates with the University of Minnesota's Climate Adaptation Partnership, which became a critically important provider of climate preparedness resources for Minnesota's agencies and communities between 2020 and 2024.

Water resource data collection

The DNR collects hydrologic data across the state, to facilitate resource management decisions related to our statutory responsibilities. These data are collected from a variety of networks and include data on lake and wetland levels, stream flow, groundwater levels, precipitation and climate. The DNR relies heavily on partners and volunteers in our data collection efforts. Soil and water conservation districts are contracted to measure groundwater levels at observation wells and record precipitation data for our volunteer precipitation observation program. MNgage is a volunteer-driven program that monitors daily precipitation. It began in the 1960s and has had about 1,500 volunteers for the past four decades. Similarly, the Lake Level Minnesota program includes around 1,000 volunteers and cooperative organizations, such as lake associations, that take readings throughout the summer at DNR-surveyed gages.

The DNR continues to improve our hydrologic monitoring networks, database and website. We updated our cooperative stream flow and groundwater webpages to provide users with better access to more types of data. We built and currently maintain a new network of 40 climate stations to supply data to agricultural producers, inform irrigation schedules and grow coverage of climate data. The long-term wetland monitoring network continues to expand to new sites across the state. These sites record water levels at 62 reference-quality wetlands, to inform scientists on the eco-hydraulic requirements of different wetland types in Minnesota. Stream flow monitoring continues in partnership with the Minnesota Pollution Control Agency (MPCA), the MDA, local governments and contractors. The DNR drilled and established more than 400 new groundwater observation wells between 2015 and 2024 and installed data loggers in more than 800 of our active observation wells across the state.

As resources allow, the DNR will continue to maintain and improve its hydrologic monitoring networks, databases and webpages. We launched a project with Minnesota IT Services, or MNIT, to enhance our web products through improved data access and new analytical tools to help interpret and explain the data to our users. We also installed cellular technology in several of our well nests and stream gages for more current and timely data delivery. Goals were set to expand the observation well and wetland networks, and staff publish annual records for many of these sites.

Stream ecological thresholds

The DNR has been collecting data on fish habitat associations from numerous streams across Minnesota since 1987, used in conjunction with models of stream hydraulics and discharge. The information helps establish the relationship between stream flow and ecological function and is fundamental to understanding the potential impact of cumulative water appropriations on the natural stream environment and ecology, which is key to sustainable water resource management.

The flow regime is the key driver of aquatic ecosystems, and its alteration, typically by increasing the variability or decreasing flows, can have negative impacts. Even during periods of normal precipitation, concentrated water use can lead to significant streamflow depletion and ecological harm. In April 2024, the Minnesota Department of Natural Resources issued a Commissioner's Order to protect the ecology of Little Rock Creek. For context, during the Little Rock Creek study period from 2006 to 2018, Augusts were predominantly wet but variable, and from the early 1990s on, the total reported water use steadily increased. The Commissioner's Order was the culmination of a Benton County stressor identification report and a Little Rock Creek watershed total maximum daily load report, followed by modeling of streamflow depletion related to groundwater use and an assessment of ecological impacts related to streamflow depletion. The Commissioner's Order describes that authorized water use in the Little Rock Creek is negatively impacting the Little Rock Creek stream ecosystem in violation of the sustainability standard and other provisions of Minn. Stat. 103G.287. The Commissioner's Order establishes the sustainable diversion limit at 15% of the August median base flow, to prevent negative impacts.

A similar process is underway on the North Branch of the Pipestone Creek (NBPC) in Pipestone County. NBPC is a warm water stream connected to the surficial aquifer and under the scope of Minn. Stat. 103G.287. Where Little Rock Creek was dominated by agricultural irrigation, water use near the NBPC includes agricultural and water supply. Similar tools will be used to assess streamflow depletion resulting from groundwater pumping, and an instream flow incremental methodology study will help assess the degree of habitat alteration, and consequently, whether the habitat change rises to the level of ecosystem harm.

Wetland science program

The DNR wetland programs provide important information to help understand wetlands and their role in Minnesota's water protection and management efforts. Wetland science programs include maintaining a statewide wetland inventory, ongoing operation of a wetland status and trends program to track gains and losses, and a wetland hydrology monitoring program. This information is used to inform decisions about wetland policy and guide wetland protection and restoration efforts.

Watershed health assessment framework

With ongoing support from the Clean Water Fund, the DNR continues to develop and enhance the Watershed Health Assessment Framework (WHAF). The WHAF has expanded into a suite of web-based platforms for accessing data and information on watershed health and natural resource context. The WHAF Explorer includes health scores and data related to each of the five components used to define the framework (hydrology, geomorphology, water quality, connectivity and biology). The WHAF has a wide range of scores and data, including information on water availability, wetland loss, stream alterations and groundwater, delivered in a dynamic map designed for exploring spatial scales.

Other WHAF applications include WHAF Lakes, which delivers health scores and related data for 3,000 scored lakes, and WHAF Land Cover, which summarizes land cover, crop cover, and water use data for user-selected boundaries. These applications also deliver many other data sets and variables for any user-selected location of interest in Minnesota.

In this way, users can note patterns and relationships between ecological context, health conditions, and the system's response. The WHAF is intended to provide information and guidance for natural resource managers, but is also used by other natural resource professionals, teachers, landowners and city planners.

WHAF highlights from 2020 to 2025

- Launched the WHAF Lakes interactive web application, to provide lake health scores for 3,000 Minnesota lakes. Using multiple ecological metrics and components, the scores help resource managers, local governments and the public better understand a range of health conditions impacting overall lake health.
- Updated the annual and seasonal 30-year climate normals with recent data for 1991 to 2020. The climate departures were recalculated to compare more recent climate data to the entire climate record. These new data layers are available online in the WHAF Explorer and for download.
- Provided annual updates on the status of impaired waters, in collaboration with the MPCA, and expanded the suite of impairment data layers available in the WHAF Explorer. Impairment changes are also incorporated annually in the stream protection priorities data layer used by our Clean Water partners for planning.

Future WHAF enhancement efforts

- Continue expansion of groundwater restoration and protection strategies-related data, in collaboration with the Minnesota Department of Health, and provide guidance for applying these data to decision-making for informed land management and groundwater protection.
- Create an updated climate health score that will better represent changing temperature and precipitation patterns, to help inform the potential impact on a range of watershed processes.
- Track watershed and lake health, to expand our reporting of trends over time.

Groundwater modeling

The relationship between groundwater and surface water bodies, and the impacts of groundwater uses on aquifers and connected water bodies, are often complex. Groundwater-flow models can be used to assess the cumulative impacts of groundwater uses on aquifer levels, and water levels and flows in surface-water bodies. Complex computer models are data-intensive and time-consuming to build. The DNR develops and applies flow models for areas of intensive groundwater use, where negative impacts are a concern and sufficient data are available.

Since 2020, the DNR has expanded the use of groundwater-flow models to examine the sustainability of groundwater use and inform water-supply planning and appropriations management in several parts of the state. DNR staff are using groundwater models to evaluate the impacts of existing and proposed groundwater uses and proposed mitigation plans on water levels in White Bear Lake (North and East Metro Groundwater Management Area) and on streamflow in Cold Spring Creek (Stearns County), Little Rock Creek (Benton and Morrison counties) and the NBPC (Pipestone County).

Finally, DNR groundwater modelers continue to work closely with managers at the City of Rochester and the City of Moorhead, who use groundwater-flow models to guide efforts in sustainably expanding their water supply systems.

Groundwater atlas mapping

Since 1995, the DNR and the Minnesota Geological Survey (MGS) have produced the County Geologic Atlas series. Each Part A atlas, completed by the MGS, describes a county's geologic and mineral resources, and the Part B, produced by the DNR, covers its groundwater resources.

The atlases describe the properties and distribution of sediment and rocks in the subsurface and characteristics of aquifers, such as sensitivity to pollution. Currently, atlases are complete for the central portion of the state, the southeast and most metropolitan area counties, and 12 other counties are in progress. The DNR makes all Part B atlas materials available as PDFs and as Geographic Information System, or GIS, files through our Groundwater Atlas Program webpage.

Geologic atlases are critical tools for a broad range of resource issues. They provide comprehensive information for planners, managers, scientists, researchers and other individuals statewide for a wide variety of projects, such as water supply planning, land use decisions, resource development, resource protection, transportation planning, agricultural water supplies, groundwater research and studies, and environmental impact statements.

The DNR Groundwater Atlas program also maintains three databases critical to understanding groundwater issues in southeastern Minnesota: the Minnesota Spring Inventory, the Minnesota Groundwater Dye Tracing Database and the Karst Features Inventory. Additionally, Groundwater Atlas staff routinely work with colleagues from other state agencies to address important groundwater issues.