



# MISSOURI WATER RESOURCES PLAN

UPDATE 2020

*As we approach the celebration of the bicentennial of Missouri's statehood, we are mindful that ours is a state born from great waters. The Mississippi and Missouri rivers are the strong roots from which the state first grew; first along the Mississippi and then up the muddy Missouri and into the West. Our rivers have been highways for American Indian migration and commerce, fur traders, explorers, Lewis and Clark, and the great riverboats of Mark Twain. Now they are commercial arteries on which we ship the fruits of our soil to the world. From the big rivers to the plains streams of the north, the clear rivers and springs of the Ozarks, and the precious water below the ground, the history of Missouri is profoundly intertwined with its water resources. So too is Missouri's future.*

As Missouri enters its third century, it is more important than ever that we plan for the future of our water. The importance of water to the life of the state cannot be overstated. Water is vital for agriculture, industry, commerce, drinking water supply, transportation, recreation, and wildlife. The Missouri Water Resources Plan is an important component of Missourians' overall water planning efforts.

As we celebrate Missouri's water resources, we recognize that we face many challenges. It is imperative that we understand how much water we have and how much we need. Our state is fortunate to have abundant water both above and below the ground, but it is often not available when and where we need it. Additionally, approximately 1.4 million more people will call Missouri home by 2060. As our population and economy grow, so will the amount of water we need. As our cities and towns grow, much of the underlying water infrastructure will be nearing the end of its expected life. Both this aging infrastructure and the regional infrastructure needed to store and move water will require investments of more than \$20 billion by 2035.

With the challenges that we face, we must continue our planning efforts at the local, state, and federal level. The Missouri Water Resources Plan explores our current and future water supplies and demands, unique subregion characteristics, infrastructure needs, available options for meeting needs, planning methods, and possible future scenarios. The plan provides key findings and recommendations for actions that the state can take to address the identified issues. We look forward to working to implement those recommendations.

We would like to thank our partners—the U.S. Army Corps of Engineers, the many Interagency Task Force members, the technical workgroup members, and other stakeholders—who provided us with their indispensable input, and the Missouri General Assembly for their support and for making the waters of our state a priority.

We hope that the Missouri Water Resources Plan will be a valuable map to guide water providers, decision-makers, and the people of Missouri as we navigate into our future.

**Dru Buntin**  
Deputy Director  
Missouri Department of Natural Resources

The Missouri Water Resources Plan (Missouri WRP) is built upon technical analysis of water demands, supply availability, water budgets, infrastructure evaluation, funding, scenario planning, and adaptive management. The key findings and recommendations described in this section are the culmination of efforts of the Missouri Department of Natural Resources (MoDNR) and statewide technical workgroups. The technical workgroups helped to identify and prioritize water issues and options for resolving the identified gaps and stresses on water supplies in the state.

## INTRODUCTION

More than any other natural resource, clean water is crucially important for Missouri. Water sustains urban and rural populations alike, and supports the state's vital agricultural industry. Water is relied upon to generate power, sustain navigation, and support numerous environmental and recreational uses. Without access to water, quality of life in Missouri would be threatened and the state's economy would cease to grow.

The Missouri and Mississippi rivers provide water supply and navigation for the eastern, central, and northwestern portions of the state. Other rivers and reservoirs have been developed by the U.S. Army Corps of Engineers (USACE) to provide various benefits, such as flood control and water supply storage within Missouri, as shown in **Figure 1**.

Although Missouri is fortunate to have rich water resources, localized shortages do exist because of the distance from adequate supplies, insufficient infrastructure or storage, water quality constraints, and other limiting factors. In many areas, surface water supplies are subject to seasonal fluctuations; supplies are frequently at their lowest when demand is the highest. The ability to store water in reservoirs—integral to surface water availability—can help to mitigate the impacts of drought episodes and other water emergencies. Groundwater supplies, particularly bedrock aquifers, are

less susceptible to seasonal fluctuations. In shallow alluvial aquifers, the aquifers and overlying streams can be linked hydrologically, with each resource impacting the other.

The Missouri WRP is a long-range, comprehensive strategy to provide an understanding of the existing use of and future need for Missouri's water resources. It will help ensure that the quantity of Missouri's water resources will meet future demands by identifying future shortfalls in water supplies and exploring options to address those water needs.

Developing a water resources plan prepares Missouri for water delivery in the face of stresses on supply caused by future uncertainties such as climate, drought, increasing demand, and supply disruption. It is imperative to look to

the future and prepare for water needs.



Figure 1. Missouri Major Cities, Waterways, and Roads



In 2016, the MoDNR Water Resources Center initiated this update to the Missouri WRP in partnership with USACE.

MoDNR has the statutory authority and responsibility in Section 640.415 of the Revised Statutes of Missouri, to develop, maintain, and periodically update a state water plan for a long-range comprehensive statewide program for surface water and groundwater uses in the state (Missouri Revisor of Statutes 2019).

## WATER RESOURCES PLAN GOALS AND OBJECTIVES

The following goals and objectives are addressed in the Missouri WRP:

- Evaluate current and future groundwater and surface water availability
- Evaluate the needs of all water users, such as drinking water suppliers, agriculture, industry, navigation, and recreation
- Develop projected water supply needs through the year 2060, taking into account projected population changes, new or increasing industry demands, and hydrologic conditions
- Identify gaps in water availability based on water use projections
- Identify water and wastewater infrastructure needs, funding, and financing opportunities
- Identify impacts affecting water availability
- Outline a series of strategies to meet Missouri's water needs
- Identify gaps in water-related datasets

## STAKEHOLDER PROCESS

The Missouri WRP included several key stakeholder engagement activities to promote and seek input on the plan as it was being created. These activities included regularly scheduled meetings of water resources stakeholders and agency representatives.

## INTERAGENCY TASK FORCE

The Water Resources Law, Section 640.430, Revised Statutes of Missouri, directs MoDNR to establish an Interagency Task Force (IATF) to promote coordination among state departments and water resource



stakeholders, ensure surface water and groundwater resources are maintained at the highest level practicable, and support present and future uses. The IATF serves as an advisory group for the Missouri WRP, providing guidance and direction. MoDNR coordinated with the IATF biannually throughout the duration of the Missouri WRP development.

## TECHNICAL WORKGROUPS

Five technical workgroups were established by water plan topic area: Consumptive Needs, Nonconsumptive Needs, Infrastructure Needs, Agricultural Needs, and Water Quality. The technical workgroups met on 12 dates in various configurations over a two and a half year period. The objectives of the technical workgroups were to provide guidance on technical analyses, give feedback to the development of technical products, identify and prioritize water resource issues, and provide recommendations on how to address those issues.



## RECOMMENDATIONS

Throughout the development of the Missouri WRP, analysis and synthesis has led to several key findings. These key findings have identified both challenges and opportunities related to water resources in Missouri, which lead to the following recommendations. The recommendations are grouped by type: **planning, implementation, funding,** and **data**. The region(s) of the state are listed following each recommendation that would benefit the most if the recommendation were implemented.

### PLANNING

- ◆ Prepare for droughts by updating the state drought plan and encouraging water supply systems to develop drought contingency plans. **statewide**
- ◆ Support regional planning groups to collaboratively and proactively address water resource challenges specific to a river basin, subregion, or watershed. **statewide**
- ◆ Focus resources to pursue water-related studies where additional information is needed to address long-term water supply availability and reliability at a watershed, regional, and metropolitan level. **statewide**
- ◆ Track ongoing agriculture industry initiatives to anticipate future agricultural water supply needs. **statewide**
- ◆ Support integrated water resources planning in areas where water shortages exist and solutions are limited or unclear. **statewide**

### IMPLEMENTATION

- ◆ Encourage and promote water conservation as a viable option within a water supply portfolio to meet municipal and industrial (M&I) water supply needs. Effective and sustained water conservation programs help defer investment in additional sources. **statewide**
- ◆ Optimize use of existing reservoir storage and develop additional reservoir storage where existing supplies are limited. **northern and southwest Missouri**
- ◆ Promote and support regionalization and consolidation, especially in areas where technical, managerial, and economic resources are limited and source waters are difficult to develop. **statewide; northern and southwest Missouri**

- ◆ Invest in improving the reliability of water supply for livestock and pasture production during periods of drought. **northern Missouri**
- ◆ Continue to work with USACE to support navigation and protect vital water supplies along the Missouri and Mississippi rivers to ensure Missouri's water needs are met. **northern and central Missouri**
- ◆ Continue dialogue with neighboring states, USACE, and other federal agencies with respect to interstate water issues. **statewide**
- ◆ Manage water resources to optimize the opportunities for nonconsumptive water needs such as navigation, power generation, recreation, aquaculture, and fish and wildlife. **statewide**
- ◆ Document, monitor, and engage regional projects that improve water supply reliability. **statewide**
- ◆ Using the adaptive management approach, continue to monitor and assess key risk triggers and identify support (through funding or other means) for projects that mitigate risk to water resources. **statewide**
- ◆ Increase coordination between MoDNR divisions and programs and across other state agencies. **statewide**

### FUNDING

- ◆ Continue to leverage existing state and federal programs, such as the Multipurpose Water Resource Program Fund, to finance water and wastewater infrastructure. **statewide**
- ◆ Offer and promote programs to educate utilities on effective rate setting that allows for replacement and expansion of infrastructure. **statewide**
- ◆ Provide continued funding for Missouri WRP implementation. **statewide**

### DATA

- ◆ Improve data and information collection to better support decision-making and future water planning and to defend Missourians' rights to utilize both surface water and groundwater. **statewide**

## DEMANDS

To manage and plan for Missouri’s future water resources, it is critical to have an understanding of how water is currently used across the state now and how that might change into the future. The demand for water is driven by the people, establishments, and economic sectors that rely on it for drinking water, personal hygiene, sanitation, filling swimming pools, washing cars, keeping lawns green, producing food, creating electricity, business uses, and manufacturing processes, just to name a few. On average, the 6.1 million people and numerous businesses in Missouri consume 3.2 billion gallons of water each day. Of that demand, 78 percent is supplied by *groundwater*, while the remaining 22 percent is supplied by *surface water* as shown in **Figure 2**. Statewide, *agriculture irrigation* comprises the largest portion of consumptive water withdrawals at 65 percent, *major water systems* makes up an additional 25 percent, and the remaining sectors represent a combined 10 percent of annual withdrawals as shown in **Figure 3**. Based



Figure 3. Current and Future Water Consumption by Sector

on growth in population, employment, and expansion of agriculture irrigation and other business sectors, statewide consumptive demand is forecasted to increase by 18 percent or 583 million gallons per day (MGD) by 2060 as shown in

**Figure 3.** Agriculture irrigation and major water systems remain the largest consumers of water in 2060.

Expressing demands as an average in MGD is useful, but these demands have a distinct seasonal pattern that peak during the summer months when outdoor water use at homes and businesses and on irrigated farmland is the greatest.

Water demands vary geographically across the state. Driven heavily by agriculture irrigation, the counties estimated to have the greatest consumptive water demand are Butler, Dunkin, New Madrid, Pemiscot, and Stoddard. These same counties have the greatest growth in demand by 2060 due

to projected increases in crop irrigation. Clusters of high consumptive demand are also found around urban areas and urban clusters. Population in Missouri is projected to increase from 6.12 to 7.48 million by 2060 (22 percent) (Woods & Poole Economics, Inc. 2017).

Not all demand for water uses it in a way that makes the water unavailable for other uses (that is, consumptive demand). Nonconsumptive demand refers to water that is withdrawn from the source or required in the stream, river, or lake to support the demand but is not consumed and remains available for other uses. While the water required for these sectors is more difficult to quantify, the importance of clean, ample water to support these uses cannot be understated. Examples of nonconsumptive uses include hydropower generation, commercial navigation, wetlands, water-based outdoor recreation, as well as aquaculture and fish hatcheries.

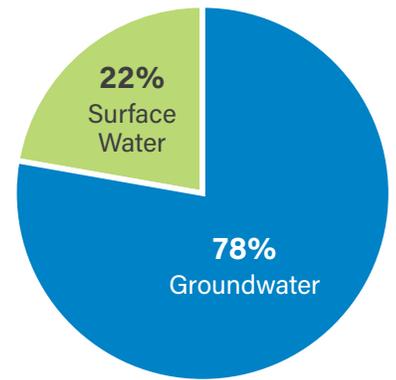


Figure 2. Current Water Consumption by Source of Water





Current and future infrastructure projects assist in bridging the gap between demands and supply while taking into account the aging nature of systems across the state. Large systems with adequate revenue have implemented proactive replacement schedules for drinking water and wastewater infrastructure to reduce the number of leaks and breaks resulting from aging infrastructure. Additionally, some major utilities are working towards prioritized replacement plans to meet main break replacement benchmarks established by the American Water Works Association. Some utilities have also developed integrated water resource plans to prioritize water resource projects in a manner that maximizes economic and social welfare benefits.

Several regional-scale infrastructure projects are being planned to address wastewater infrastructure and water supply shortfalls. These projects include the construction of two reservoirs in northern Missouri and a reservoir in southwest Missouri, a water supply reallocation in southwest Missouri, and a regional water conveyance system in northwest Missouri. Projects such as these continue to be necessary to overcome the obstacles associated with aging infrastructure and regional infrastructure gaps. Significant investment in water and wastewater infrastructure will be critical for the state's future water needs.

## FUNDING OPPORTUNITIES

The following is a summary of the findings associated with funding opportunities in Missouri:

- Funding for developing and maintaining public drinking water and wastewater systems is available through multiple federal, state and private sources.

## WATER SUPPLY

Missouri has an abundant supply of water, both in the ground and on the surface. Precipitation falling within the state provides over 15 trillion gallons of runoff water to rivers, lakes, and streams during an average year. More than twice that amount of water—38 trillion gallons per year—enters the state in or by the Missouri and Mississippi rivers. Precipitation infiltrating the ground replenishes aquifers that provide an estimated 500 trillion gallons of potable groundwater storage within the state (Miller and Vandike 1997).

For the Missouri WRP, the potential for water stress and gaps was investigated using a water budget approach. The water budgets account for the mostly natural movement of water within the hydrologic cycle and the movement of water resulting from human activities, as shown in **Figure 4**.

## INFRASTRUCTURE

Adequate and reliable water and wastewater infrastructure is essential to human health and economic development and preservation of Missouri's waterways. While much of Missouri's water and wastewater infrastructure is in need of significant upgrades and repairs, utilities and water providers face financial challenges with updating this equipment.

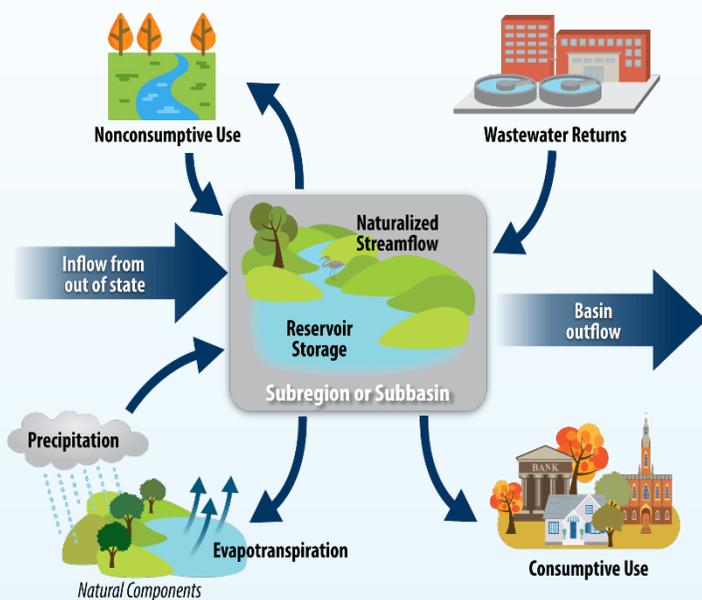


Figure 4. Surface Water Budget Schematic



- MoDNR's Financial Assistance Center includes a team of engineers, project coordinators, and administrative staff dedicated to assisting Missouri communities plan and fund water, wastewater, and stormwater infrastructure projects.

Adequate and reliable water and wastewater infrastructure is vital to public health and the prosperity of Missouri's communities. The ability to effectively develop and properly maintain this critical infrastructure is often contingent on outside funding such as loans and grants. One such source is the Multipurpose Water Resource Program Fund, a statewide program administered by Missouri Department of Natural Resources that focuses on providing financial assistance to drinking water projects which are ineligible for Drinking Water State Revolving Fund. Other sources of funding for water and wastewater systems are available through multiple federal and state sources, though grants are limited. Loan and grant opportunities often have cost-share or matching requirements that may be difficult to secure, especially for small utilities. Public finance sources are also available, including public bond markets, bank programs, and bond funds. Each of these programs has its own requirements, structural components, incentives, and drawbacks.

## OPTIONS TO MEET FUTURE WATER NEEDS

The following is a summary of the findings associated with water supply options in Missouri:

- A portion of Missouri's immediate water supply needs can be addressed through projects and planning processes that are currently being pursued by local and regional water providers. As new water supply needs or challenges emerge, there are numerous and diverse options available to water providers and users that can be implemented independently or in combination to meet these needs.
- Municipal and industrial options include additional storage (new or expanding existing), conveyance, enhanced water treatment, wastewater reuse, expanded conservation, conjunctive use, system redundancy, and regionalization.
- Agriculture options include additional storage, conveyance, conjunctive use, system efficiencies, recycled water, expanded groundwater use, and surface impoundments.

Missouri has a large supply of water overall, but it is not always found when and where it is needed, nor is it always

of a usable quality. While many of Missouri's immediate water supply needs will be addressed through projects and planning processes that are currently being pursued by local and regional water providers, there are other emerging water supply needs or challenges that still must be addressed. Water providers and users will need to consider a variety of water supply options, either independently or in combination, to meet these needs. The water supply options are grouped according to the two primary sectors of water demand for which they apply—M&I and agricultural. Each option has specific advantages, disadvantages, and cost and environmental implications that must be considered.

## PLANNING METHODS

As an alternative to traditional water planning, scenario planning is a technique that captures a wider range of uncertainties and risks. Scenario planning is a structured process by which future uncertainties are bundled together using scenario narratives that represent plausible future conditions. Impacts for each scenario, such as water supply shortages, are then estimated. Adaptive management is a useful tool when used in combination with scenario planning to develop implementation strategies for dealing with uncertainty in a structured fashion.

## FUTURE SCENARIOS ASSESSED

Following the scenario planning process and with input from the technical workgroups, the following four planning scenarios were formulated for analysis:

1. Business as Usual (also known as the baseline scenario).
2. Strong Economy/High Water Stress.
3. Substantial Agricultural Expansion.
4. Weak Economy/Low Water Stress.

**Figure 5** on the following page shows the relative level of surface water and groundwater stress for each scenario by subregion for both average and drought conditions. The subregions in the central and northern part of Missouri are expected to have the highest likelihood for water supply gaps under the Strong Economy/High Water Stress scenario. In the Lower-Mississippi-St. Francis subregion, the most stress and highest potential for gaps are expected under the Substantial Agricultural Expansion scenario; however, the assumptions behind the supply source (groundwater versus



*Crowder Lake near Trenton*

surface water) to meet the increased demands of this scenario play a large role in determining that potential. In the Neosho-Verdigris subregion, the highest potential for stress and gaps occurs under average conditions with the Strong Economy/High Water Stress and Substantial Agricultural Expansion scenarios. Under drought conditions, the Business as Usual and Weak Economy/Low Water Stress scenarios would be expected to show the highest level of stress because of no reservoir reallocations and the assumption that no new reservoirs are constructed.

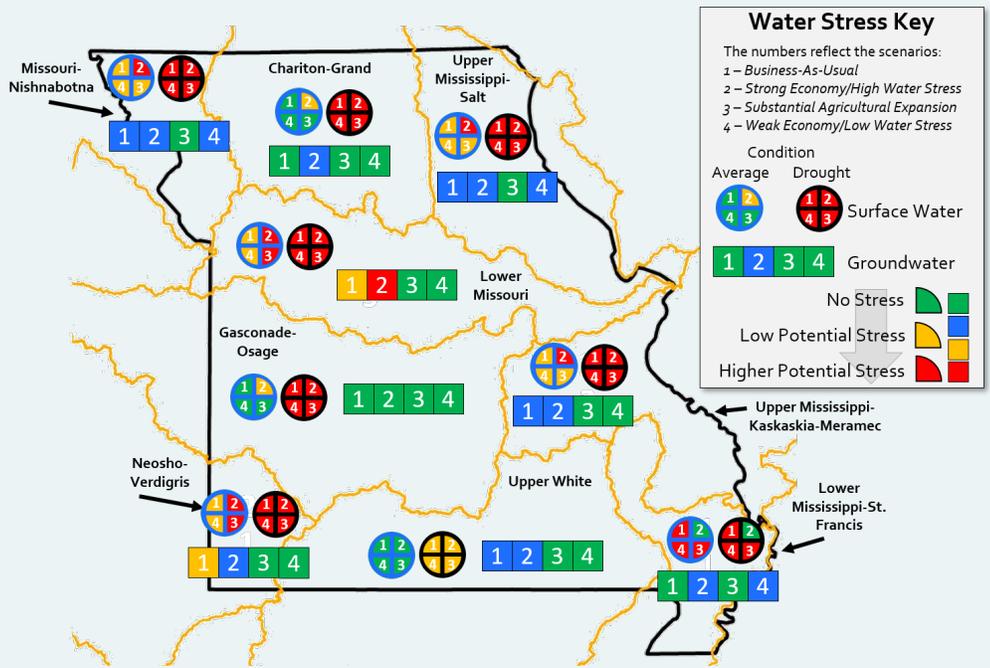


Figure 5. Scenario Results Showing Stress Level in Each Subregion for Average and Drought Conditions

## IN SUMMARY

### The 2020 Missouri Water

**Resources Plan Update is a data centered WRP. This WRP used analysis and forecasting tools to define its water resources needs through 2060. This was accomplished by projecting water demands through 2060, analyzing the available surface water and groundwater by sub-region and associated gaps and then identifying options to meet any potential water resources shortages. Although the future is uncertain, scenario planning was used to bracket the range of future uncertainties. This plan and future water resources planning efforts will guide water providers, decision-makers, and the people of Missouri to navigate the future.**

Prepared by



For



In cooperation with

