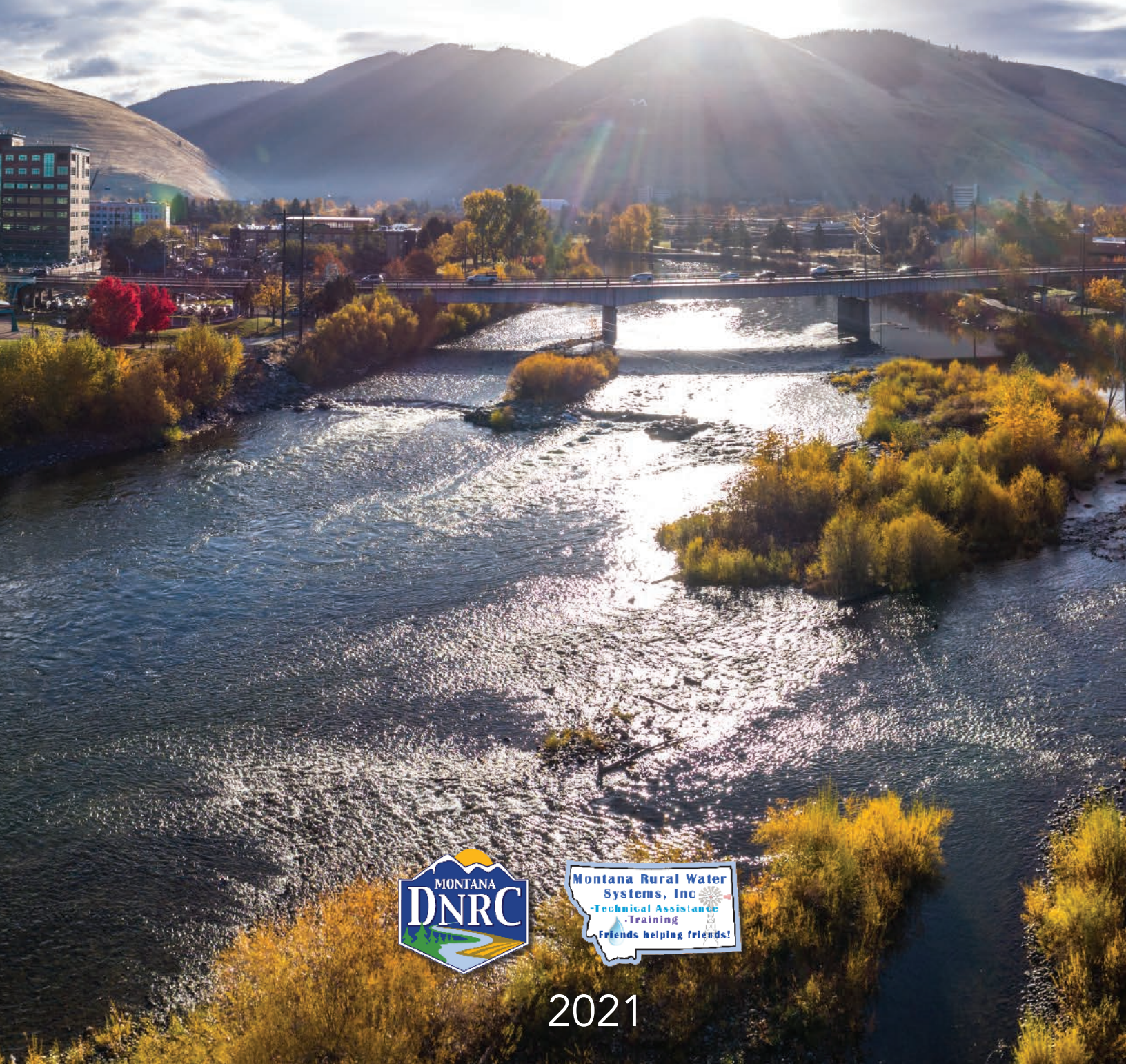


# Integrated Water Resources Planning and Management Guide

FOR MONTANA MUNICIPALITIES



2021

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← FILTERED WATER

← SETTLED WATER



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# Integrated Water Resources Planning and Management Guide

FOR MONTANA MUNICIPALITIES

## 1.0 INTRODUCTION

Integrated water resources planning (IWRP) and management is a continuous process of evaluating and documenting water supply, demand and quality while identifying a suite of cost-effective, socially acceptable and environmentally sound management strategies.

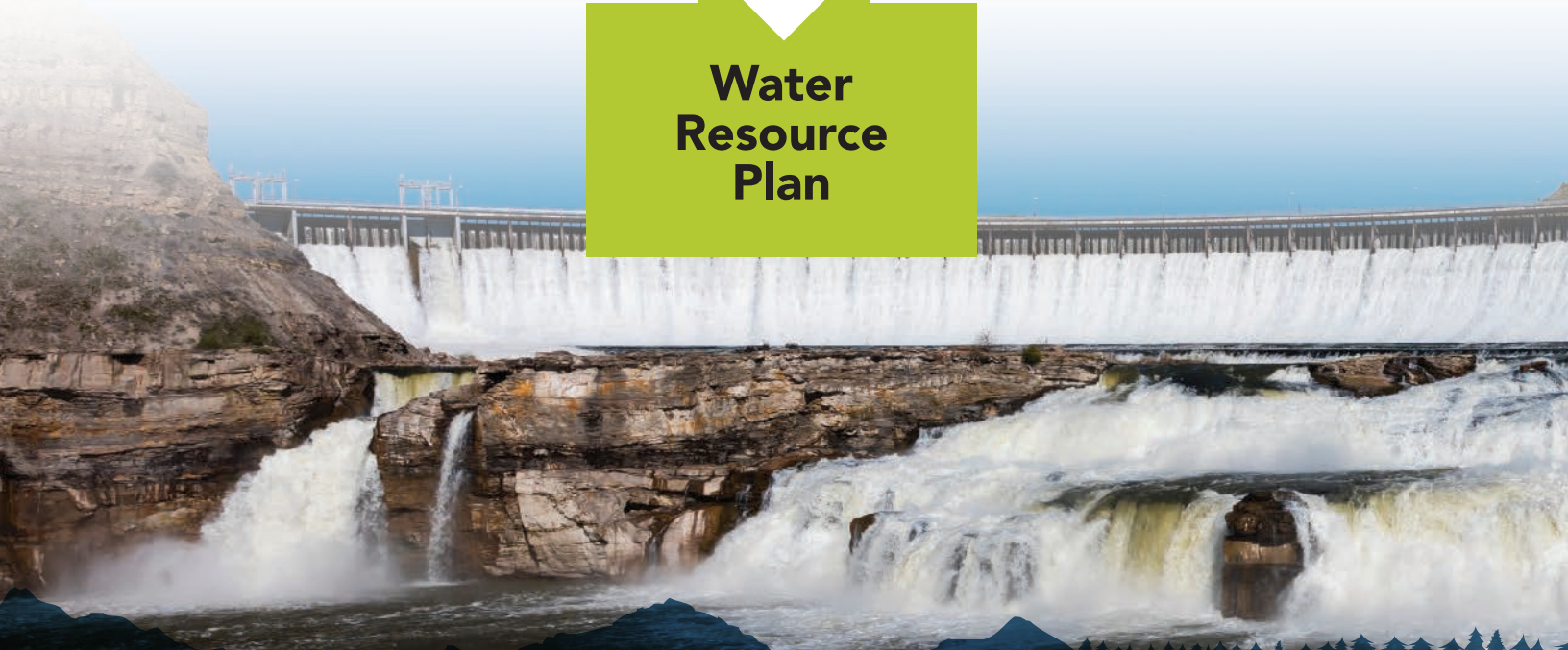
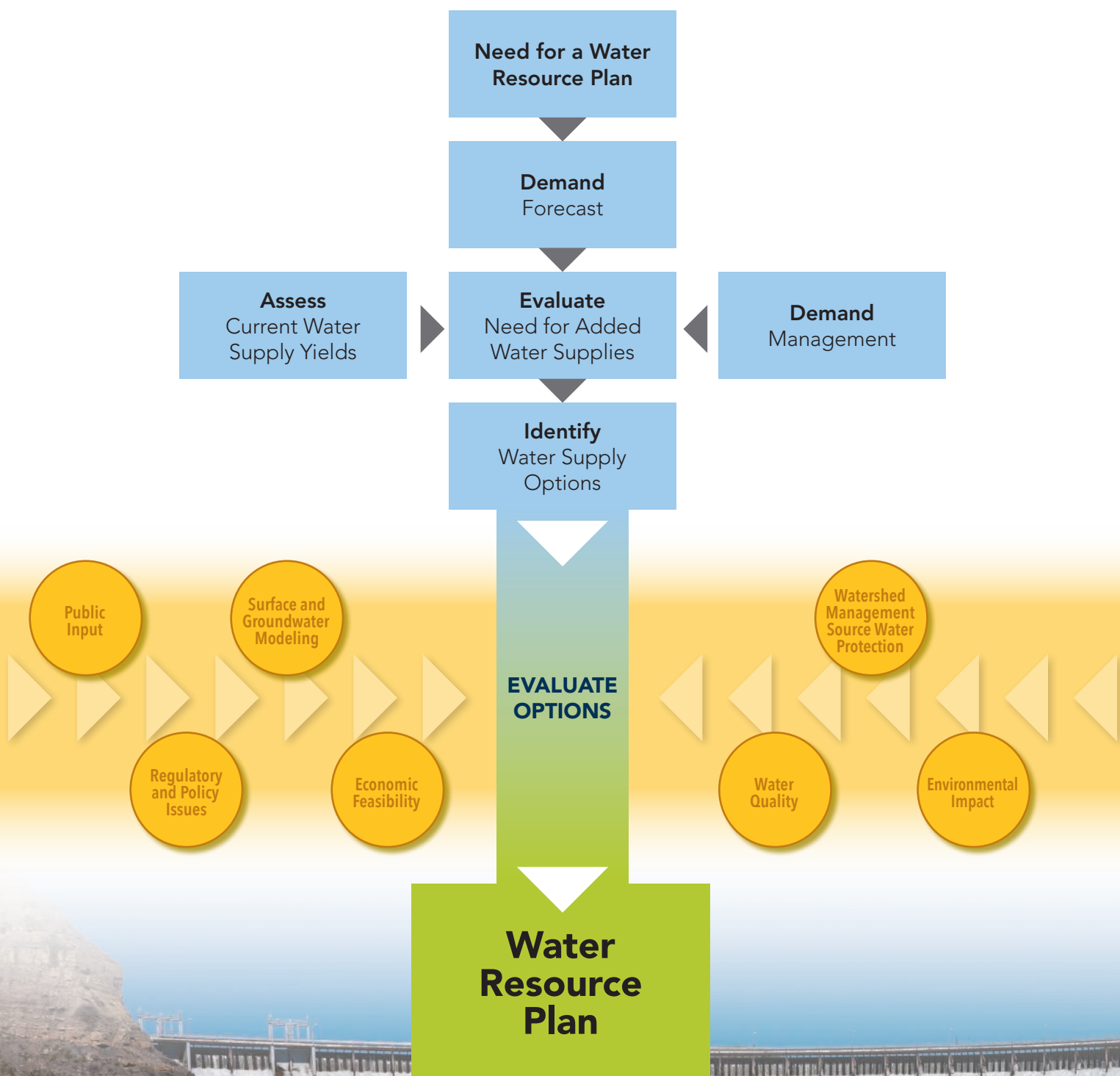
The IWRP process can be used at the local, county or regional level to meet an area's specific water needs. Many factors affect the supply and demand for water in an area, and the IWRP process can help to identify and plan for effective water management strategies within a specific location or public water system (PWS).

The IWRP process helps public water systems improve water supply resilience and reliability in the face of uncertainties like aging infrastructure, more intense drought and other climate change impacts. Primary components of the IWRP process include evaluating current and future water demand, assessing potential water supply vulnerabilities, comparing projected water demand to the amount of water available from existing sources, and quantifying when and how much water a PWS will need to meet future demands.

The City of Bozeman, Montana used the IWRP process to implement water conservation measures and develop and evaluate a broad range of water supply management options to meet future water supply needs.

An example of the IWRP process is shown on the following page. However, since every model and system are different and the planning process changes depending on a system's specific needs and goals, not all IWRP planning models are the same. The approach presented here is similar to the American Water Works Association (AWWA) IWRP process.

# SAMPLE INTEGRATED WATER RESOURCES PLANNING (IWRP) PROCESS



The scope of the IWRP process can range from a comprehensive water resources evaluation using software models to a simple assessments summarizing existing water demand, supply, and operations and outlining future goals. Many public water systems do not have the financial, technical, or human capacity to complete a comprehensive water resources plan. **The purpose of this IWRP guide is to help public water systems assess their water supply and water demand to identify potential vulnerabilities and develop long-term solutions. Moderate planning is infinitely more valuable than no planning.**

*This document is an Integrated Water Resources Planning kick-starter for Montana public water systems that provides:*

- An overview of water resources planning and management concepts, tools and evaluation methods.
- A logical water resources planning process to support Montana public water systems in future water planning and management, while allowing for variances in geographical location, size, water sources, and financial resources.
- Planning tools (checklists, worksheets, references, examples, and “how-to” guidance) for Montana PWS to start the IWRP process.
- Additional and relevant resources to enable public water systems to dive in deeper with planning.

*This guide consists of the following sections:*

**Water Supply** Water Supply Assessment and monitoring strategies and guidance on the key components of water supply, water rights evaluation and water system vulnerabilities.

**Water Demand** How to assess current and future water demand using water use patterns and historical data.

**Other Planning Approaches** Description of planning approaches including water efficiency and conservation, drought management and source water protection.

## GETTING STARTED CHECKLIST

- Identify and describe main planning objectives
- Gather and organize historical water supply data
- Gather and organize water rights information
- Identify the most critical vulnerabilities and complete vulnerability assessment form
- Gather and organize historical water demand data
- Identify data gaps
- Calculate projected water demand
- Engage the community
- Solicit participation from local agencies and nongovernmental organizations as applicable

## 2.0 WATER SUPPLY

A water supply evaluation analyzes existing water supplies to more formally define the yield and to assess the ability of the system to meet future demands. A key component of the water supply evaluation process is to categorize and evaluate existing water rights by source and quantity. It may be necessary to identify and evaluate alternative water supply sources during this process.

### Water Supply Monitoring

Water supply monitoring requires consulting various resources depending on a community's setting and water source. Data including streamflow, reservoir levels, groundwater levels, soil moisture, snowpack and climatological variables may be useful to monitor.

#### Streamflow

- [U.S. Geological Survey Stream Gage Data](#)
- [State of Montana Surface Water Assessment and Monitoring Program \(SWAMP\) Stream Gage Data](#)
- [Montana DNRC Stream Gage Program \(Stream and Gage Explorer\)](#)

#### Reservoir Storage

- [State Reservoirs](#) search “reservoir storage”
- [Federal Reservoirs](#)

#### Groundwater Information

- [Montana Bureau of Mines and Geology](#)

#### Snowpack

- [Natural Resources Conservation Service \(NRCS\) Montana Snow Survey](#)

#### Soil Moisture

- [Montana Climate Office, MT Mesonet](#)

#### Climate and Remote-Sensing

- [Desert Research Institute/University of Idaho](#)

#### Drought Conditions

- [US Drought Monitor](#)

The U.S. Drought Monitor is a map that depicts weekly drought status across the U.S. For Montana, it relies on expert input from a subcommittee of the Montana Governor's Drought and Water Supply Advisory Committee. Members of this subcommittee represent several state and federal agencies, the MT Climate office, tribes, universities, and others who correspond with the U.S. Drought Monitor map authors weekly to assess the latest drought conditions.





*Common drought indices:*

DROUGHT INDEX	PARAMETERS	ADVANTAGES	DISADVANTAGES
<b>US Drought Monitor</b>	<ul style="list-style-type: none"> <li>• Precipitation</li> <li>• Temperature</li> <li>• Evapotranspiration</li> <li>• Soil Noisture</li> <li>• Runoff</li> <li>• Moisture Loss</li> <li>• Snow Water Content</li> </ul>	<ul style="list-style-type: none"> <li>• Includes multiple parameters</li> <li>• Provides consistent drought conditions</li> </ul>	<ul style="list-style-type: none"> <li>• Multi-sector index that tends to emphasize agricultural impact</li> <li>• Broad coverage area</li> <li>• Does not capture local conditions</li> </ul>
<b>Standard Precipitation Evapotranspiration Index (SPEI)</b>	<ul style="list-style-type: none"> <li>• Rainfall</li> <li>• Evapotranspiration</li> <li>• Temperature</li> </ul>	<ul style="list-style-type: none"> <li>• Can be computed for different time scales</li> </ul>	<ul style="list-style-type: none"> <li>• Excludes water storage in snowpack</li> </ul>
<b>Standard Precipitation Index (SPI)</b>	<ul style="list-style-type: none"> <li>• Precipitation</li> </ul>	<ul style="list-style-type: none"> <li>• Can capture signals of water stress at weekly and monthly timescales</li> </ul>	<ul style="list-style-type: none"> <li>• Does not account for evapotranspiration; sensitive to data quality; does not account for impacts to snowpack</li> </ul>

**Drought Conditions**

*Additional drought monitoring resources include:*

- [National Integrated Drought Information System](#)
- [Montana DNRC Drought Management](#) (including the Drought Impacts Reporter – for reporting local moisture conditions)
- [US Drought Monitor](#)
- [Westwide Drought Tracker](#)
- [Upper Missouri River Basin Drought Dashboard](#)



## 2.1 WATER RIGHTS EVALUATION

Many public water systems have water rights that are not much greater than their current or future estimated water demand. All systems should perform an evaluation to understand and document their existing water rights. Understanding water rights is crucial to plan appropriately for increased water use and future growth. Systems also need to account for seasonal water rights in their overall water rights portfolio, since seasonal water rights may be more restrictive.

### Montana Water Law Overview

Montana water is property of the state for use by its people. All citizens must attain a water right to put water to a beneficial use. Montana, like other western states, follows the Prior Appropriation Doctrine in water rights administration, so earlier priority dates are considered "senior" and are generally more reliable in the event of water shortages.

*Every water right has these components:*

- Owner(s)
- Priority date
- Type of historic right (decreed, filed or use right)
- Purpose (and irrigation type, if relevant)
- Flow rate (if appropriate for purpose)
- Volume (if appropriate for purpose)
- Maximum acres (for irrigation, lawn and garden)
- Source name and type
- Point(s) and means of diversion
- Period of use
- Place of use

Some river basins in Montana are legislatively closed to new surface water uses, which precludes water users from attaining new water rights unless they're able to somehow mitigate, or offset, the new use.

Public water system officials should have a comprehensive understanding of their water rights, including how they impact overall operations and long-term planning. Every PWS should go through the following steps to understand their water rights:

1. Research current water rights information using the MT DNRC water right query system ([wrqs.dnrc.mt.gov](http://wrqs.dnrc.mt.gov)).
2. Complete the following water rights table. Document water rights and distribute internally so that key PWS officials understand instantaneous and annual water right limitations, including period of use restrictions as applicable:

WATER RIGHT ID NUMBER	WATER SOURCE	PRIORITY DATE	PERIOD OF USE	MAXIMUM INSTANTANEOUS WITHDRAWAL RATE (CFS)	MAXIMUM ANNUAL USE (AC-FT)
<b>TOTAL</b>					

3. Develop a chart of seasonal water rights (if applicable) to easily illustrate water rights throughout the year.

### Water Reservations

The water reservation process in Montana allowed municipalities, among other governmental entities such as conservation districts, to reserve water to meet future beneficial uses that are in the public interest. For municipalities, this involves providing for future population growth. A 2016 DNRC report identifies 33 municipalities in the Missouri and Yellowstone River Basins that hold water reservations. For planning purposes, all communities should know if they have water reservations and what volume is reserved. The current deadline for finalizing or "perfecting" water reservations is December 31, 2025.

## 2.2 VULNERABILITY ASSESSMENT

Vulnerability assessments help evaluate the reliability of a water system and the factors that pose risk to the source, supply, treatment and distribution systems. The vulnerability assessment is intended to identify the most critical vulnerabilities so a system can develop and implement strategies to minimize those risks. It is important to assess a wide range of threats and potential impacts. First, develop a list of potential weaknesses or threats to your water system and then summarize the potential impacts to the system.

*Some of the more common vulnerabilities include:*

- **Water source / supply diversity** A single surface water source is more vulnerable to drought or infrastructure failures than multiple sources.
- **Reservoir size** Is year-over-year storage capacity present, or could one severe drought year result in a water shortage?
- **Size of river** Is the source a small stream versus a large river? Smaller rivers or streams can be more vulnerable to localized drought conditions or droughts of short duration.
- **Reliance on snowpack** Timing and duration of runoff impacts to water supply.
- **Groundwater supply**
  - How large is the aquifer relative to the PWS?
  - What is the reliable, or firm, yield versus demand? (Firm yield is the maximum quantity of water that can be delivered by a spring or reservoir during a severe drought.)
  - The water right (paper water) may exceed the actual, firm yield.
  - If budgets allow, consider having a hydrologist or hydrogeologist assess the firm yield of your water source.
- **Number of water users and other water demands** on water source, including communities, industry power generators, and irrigators.
- **Water rights** If demand within a PWS is encroaching on existing water rights and the PWS has no water reservation, then the supply is vulnerable to growth pressure and increased demand. If the PWS is in a closed basin, then the vulnerability is more critical.
- **Seasonal water rights** Assess PWS capacity during times when water rights flow or volume are lowest.
- **Junior water rights** Subject to calls by senior water rights holders when there is a shortage.
- **Climate change**
  - Is the PWS supply susceptible to prolonged changes in weather patterns and impacts to water supply?
  - PWS managers should apply a safety factor for climate change when evaluating firm yields.
  - If budgets allow, obtain a climate change model-based prediction of water supply impacts.
- **Infrastructure vulnerabilities**
  - Are there “single points of failure” in supply, treatment, transmission or distribution? For example, a water supply may be conveyed to users via single transmission pipeline of substantial length - what if there’s a major break in this pipeline?

## Climate Change Vulnerabilities

The U.S. Environmental Protection Agency developed a web-based software application tool entitled Climate Resilience Evaluation and Awareness Tool (*CREAT*) to assist drinking water and wastewater utility owners and operators understand potential climate change threats and assess the related risks at their individual utilities. The goals of CREAT include:

- Increase drinking water, wastewater, and stormwater operator awareness of potential climate change impacts on operations.
- Guide utilities through the risk assessment process.
- Inform decision-making by identifying adaptation options.
- Examine costs of adaptation options compared to economic losses resulting from climate change threats.

WATER SUPPLY VULNERABILITY <sup>1</sup>	YES	NO	DESCRIPTION OF VULNERABILITY/ LIMITATION	MITIGATION PLAN TO ADDRESS VULNERABILITY
Water rights limited with no additional water reservation				
Seasonal water rights				
Susceptibility of water rights, junior rights				
Water supply - number of supplies, diversity of supply types				
Raw water storage - capacity for year over year storage				
Surface water source - document minimum flow / level				
Reliance on snowpack				
Groundwater supply - size of aquifer, firm yield, well redundancy				
Other water users / demands on source / seniority				
Water loss / non-revenue water				
High population and/or demand growth				
Climate change impacts				
History of drought or water supply shortages				
Aging infrastructure needing repair or replacement				
Single points of infrastructure failure				
Water supply contamination risk				
Susceptibility of watershed to wildfire				
Invasive species, risk and impacts				

<sup>1</sup> Adapted from Colorado Water Conservation Board. *Municipal Water Efficiency Plan Guidance Document*. Boulder, CO: AMEC Earth & Environmental (2012).

## 3.0 WATER DEMAND ASSESSMENT

### 3.1 WATER METERING

Water metering in this context refers to not just the typical point-of-use metering (residences, industries, etc.), but also to metering at the water supply source(s) and strategic locations throughout the distribution system. Water metering can help:

- **Identify** water loss or inefficiencies within a water system and discourage excessive water use. The Alliance for Water Efficiency reports that metered customers typically use 15% to 30% less water than un-metered customers.
- **Enable** volume-based billing (as opposed to flat rates) and provide a better understanding of water use within a PWS.
- **Inform** predicted future water demand.

Source water metering can be as simple as installing flow meters on raw water pipelines or level sensing devices on flow control structures. At a minimum, metering of treated/finished water at the source and/or introduction to the distribution system is necessary to document water use and ensure water rights compliance. Water supply metering can also be used to characterize seasonal water demand, although it does not reveal information regarding water loss.

Metering at the point of delivery uses inline meters with various flow measurement methods. There are several types of commonly used water meters including displacement, turbine, electromagnetic, and others. The technology choice depends on the flow measurement installation conditions, the type of end user, the flow rates expected, and accuracy requirements. In North America, standards for manufacturing water meters are established by the American Water Works Association.

Meters can range in cost from as little as \$50 for residential meters to \$5,000 for industrial sized meters, but installed costs vary more depending on new construction versus retrofits, meter box designs, and other factors.

Automatic meter reading (AMR) systems enable remote reading, often by driving near the meters with a vehicle-mounted radio that downloads data from meters with radio signal capabilities. More advanced AMR systems consist of water meters, two-way communication system, data storage, and water use data software programs.

Master metering or submetering strategies can improve data collection throughout a water system. Master metering uses a meter on a water service line for multiple end users, whereas submetering consists of installing separate water meters for individual end users within a facility.



## 3.2 WATER DEMAND CHARACTERIZATION

Water demand characterization is the process of evaluating a water system's water use patterns. Water demand characterization can provide a PWS with a basis for projecting future water demands and comparing the projected demand to the amount of water available from existing water sources. Demand data is critical in assessing the capacity of the existing water system and ensuring that supply is adequate to meet demand.

Important factors influencing water demand patterns include customer population and number of connections, water rates and the rate structure, customer income, weather variables, industrial use, housing characteristics (e.g., size of lawns), frequency of billing rates and indoor versus outdoor water use.<sup>1</sup>

*An effective water demand characterization typically includes:*

- Historical water use patterns (e.g., water use by day, month, and year; correlation with historical population estimates, growth patterns, and weather/climate / seasonal patterns).
- Estimated population growth within the PWS service area.
- Predicted future water demand within the planning timeframe.

The end goal is to predict when water demand will encroach upon or potentially exceed the source water supplies, water rights, or infrastructure capacities.

*Water Demand (use) is most often described in the following terms:*

**Average Annual Demand (AAD)** The total volume of water delivered by the system in a full year, expressed in gallons, millions of gallons (mg) or acre feet (ac-ft).

**Average Daily Demand (ADD)** The total volume of water delivered by the system over a year divided by 365 days. The average use in a single day expressed in gallons per day.

- **Averaged Daily Winter Demand (Winter Demand)** The gallons per day average during the months of December, January, and February when system demands are typically low. This is often considered a community's "indoor water demand," and/or the minimum amount of a water that a community needs when considering water rate structures, drought stage responses, etc.
- **Average Daily Summer Demand (Summer Demand)** The gallons per day average during the months of June, July, and August when system demands are typically high due to irrigation.
- Comparing daily winter and summer demands sheds light on how much water a community uses for outdoor irrigation.

**Maximum Month Demand (MMD)** The gallons per day average during the month with the highest water demand. The highest monthly usage typically occurs during the summer and is due to the higher evapotranspiration rate (sum of evaporation and plant transpiration) during irrigation of turf grasses and ornamental landscapes.

**Maximum Day Demand (MDD)** The largest volume of water delivered to the system in a single day expressed in gallons per day. MDD is an important parameter for assessing water supply and storage capacity.

**Peak Hourly Demand (PHD)** The maximum volume of water delivered to the system in a single hour expressed in gallons per minute.

**Peaking Factor (PF)** The ratio of maximum flow to the average daily flow in a water system. Commonly, this is the ratio of maximum day demand to average daily demand. Typical values for peaking factors range from 2-4. Peaking factors are influenced by weather conditions, the pressure or absence of adverse water user class, and amount of precipitation.

**Total Production** Total treated water transferred to the distribution system.

<sup>2</sup> Palmer, Richard N., and Kathryn V. Lundberg. *Integrated Water Resources Planning*. [www.isws.illinois.edu/iswsdocs/wsp/IWRP\\_Palmer\\_Lundberg.pdf](http://www.isws.illinois.edu/iswsdocs/wsp/IWRP_Palmer_Lundberg.pdf)

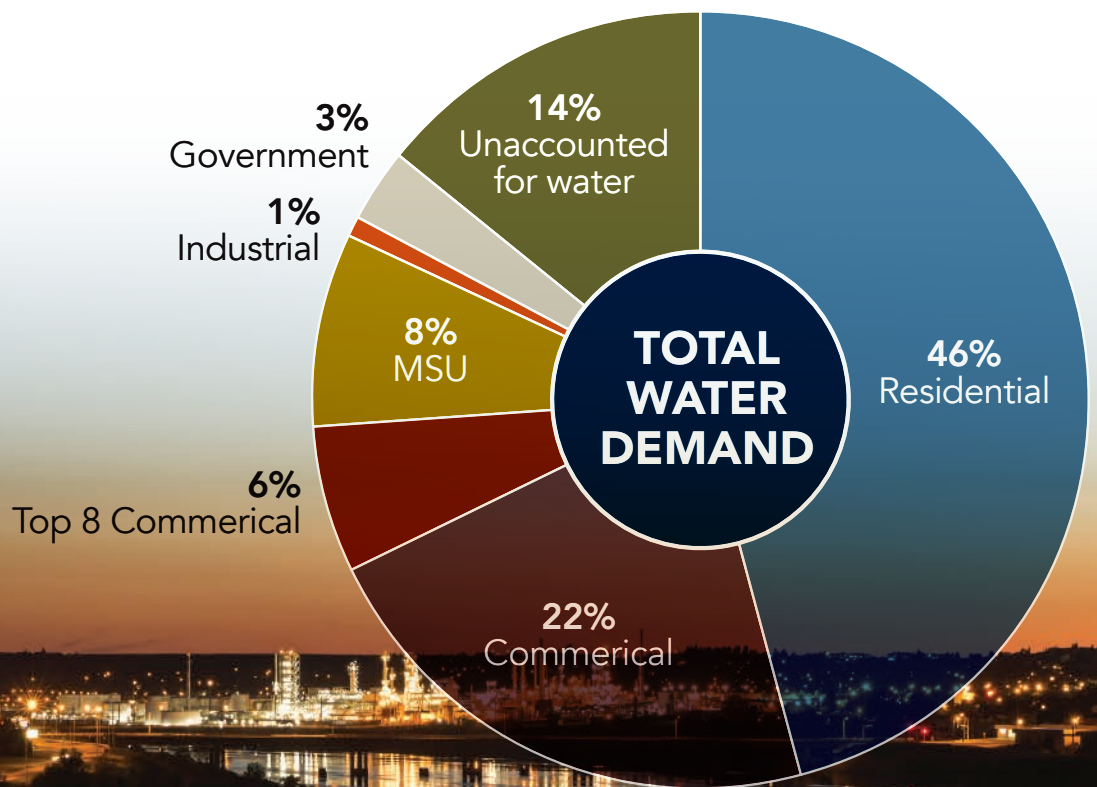
Ideally, historical water use data should come from metered supplies and water billing records. The PWS should maintain a meter database and track the following parameters:

- Number and type of connections
- Total treated water produced
- Total distributed water
- Total metered water (where households are metered)
- Total billed water
- Water use by user class (i.e., residential, commercial, or industrial)
  - Estimate total water demand across each user class
  - Identify largest water users and discuss operations to understand their usage.
- Per capita water use - gallons per capita (person) per day (gpcd). Characterizing water use on a per capita basis enables future water use forecasting based on available estimates for population growth within the PWS service area.

Comparing total distributed water (at the source or treatment facility) to downstream metered or billed water provides valuable information on overall water efficiency and may indicate significant leaks in the system (90% efficiency is a typical threshold for good efficiency).

Analyzing water demand by user class can reveal where a PWS can get the best return on investment regarding water conservation. The figure below provides an easily understood visual of water use by classification for the City of Bozeman.

Whether your PWS is metered or not, knowing and understanding the largest water users within your water system is beneficial. Communication with the largest users can improve understanding of how and when water is used and strengthen planning for future water use.



Comparison of indoor and outdoor water (irrigation) use can reveal whether a PWS can benefit from a water conservation program. Indoor water use is typically characterized as water use between November and March, since irrigation is usually not a significant demand during this period. Comparing this to summer irrigation water use (usually June through September) enables the PWS to identify how much water is used for irrigation. This can be important for drought planning, as it can indicate how much water could be saved via water conservation or drought stage implementation. An example water use table is shown below.

MONTH	WATER USE (GALLONS)		
	INDOOR	OUTDOOR	TOTAL
January			
February			
March			
April	Estimate Based on Winter Total Use		
May			
June			
July			
August			
September			
October			
November			
December			
<b>TOTALS</b>			

### Water Demand Projections

Long-term water demand projections are critical to address growth and water supply planning, and to develop appropriate capital improvements plans (CIPs). Water demand projections can be based on a variety of input data, including population, historical water use patterns, land use plans, water rates, and most importantly, the availability of water. Water demand characterization typically entails forecasting baseline (average annual) water demand, predicting peaking factors for maximum day demand, incorporating future growth policy, and ultimately balancing water use with water supply.

Water demand forecasts are most often developed by extrapolating from past water demand patterns and correlating to population estimates. This enables “per capita” projections, which defines water use by person (expressed as an average across the population), usually in units of gallons per capita day (gpcd).

A general, step-by-step approach to developing water demand projections based on historical water use to determine future water demand is outlined below.

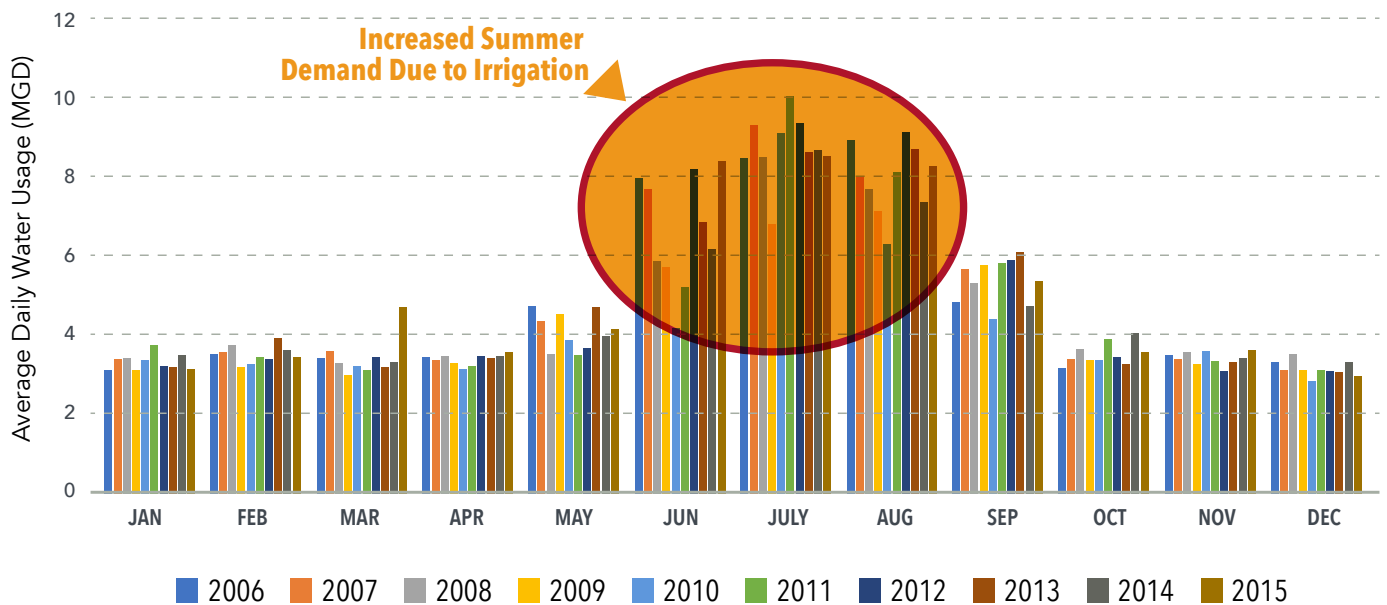
1. Calculate average annual demand, average monthly demand, and maximum day demand.
  - Ideally, calculate these demands based on a minimum of three years of data, to dampen the impacts of very dry or wet years.
  - Break down demand over the course of the year, as shown in the monthly usage table and chart on the next page, which illuminates irrigation use versus indoor water use.



YEAR	MONTH	AVERAGE DAILY DEMAND (ADD)
2019	January	
2019	February	
2019	March	
2019	April	
2019	May	
2019	June	
2019	July	
2019	August	
2019	September	
2019	October	
2019	November	
2019	December	

- Estimate population and population growth rates based on available tools:
  - Local growth policy / planning documents (City, County)
  - U.S. Census data
  - Historical population growth - use past trends to project
- Multiply your estimated average annual growth rate by the current population to create projections for future years. Typically, this is done for twenty- or thirty-year planning horizons.
- Determine the annual per capita water use for each year of the demand and population data samples. Estimate per capita use based on an average of the most recent years to dampen seasonal variability.

### AVERAGE DAILY WATER USAGE PER MONTH

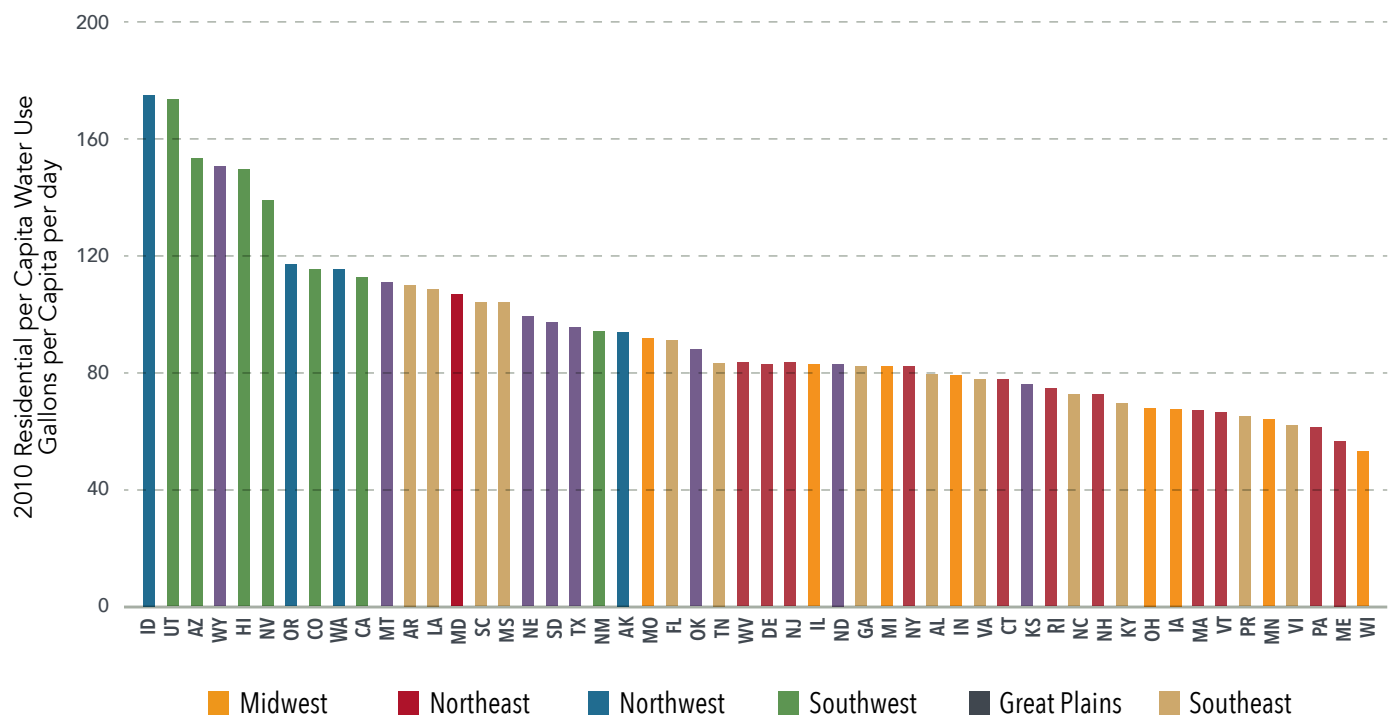


A	B	C	D	E	F	G	H
YEAR	TOTAL PRODUCTION	AVERAGE DAILY DEMAND (ADD)	MAXIMUM MONTH (MMD)	MAXIMUM DAY (MDD)	POPULATION ESTIMATE	AVERAGE ANNUAL GPCD	PEAK GPCD
2013	From Data Collection and Historical Records					= CxF	= ExF
2014							
2015							
2016							
2017							
2018							
2019							
<b>AVERAGE</b>							

Montana is ranked 11th in the U.S. for residential per capita water use at approximately 107 gal per capita per day (gpcd). Communities with little water loss (indicating distribution pipelines are in good condition) and water conservation programs and rate structures might have demand of 70 to 90 gpcd. Communities with higher water loss and/ or more irrigation use will trend above 120 gpcd. Western states tend to have higher evapotranspiration rates and generally require more irrigation, contributing to higher per capita water use.

Future water demand is projected based on recent water demand and population data as described previously.

### PER CAPITA WATER USAGE BY STATE AS OF 2010<sup>2</sup>



<sup>3</sup> Shafer, M., D. Ojima, J. M. Antle, D. Kluck, R. A. McPherson, S. Petersen, B. Scanlon, and K. Sherman, 2014: Ch. 19: *Great Plains. Climate Change Impacts in the United States: The Third National Climate Assessment*, J. M. Melillo, Terese (T.C.) Richmond, and G. W. Yohe, Eds., U.S. Global Change Research Program, 441-461. doi:10.7930/J0D798BC.

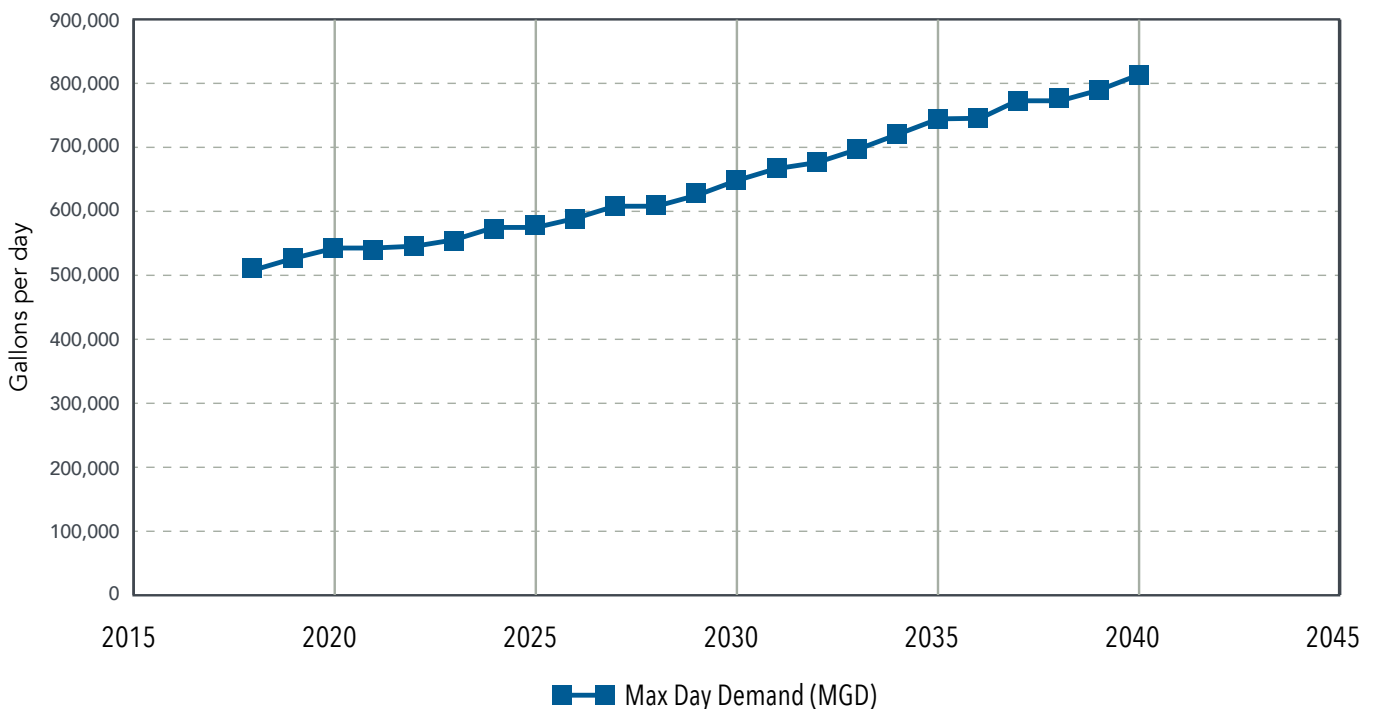
However, any future projections should incorporate a range of potential changes in population and demand to avoid under- or overestimating future demand. This is generally referred to as scenario planning:

1. Multiply the projected populations in future years by the per capita water usage developed previously.
2. Develop a range of water use and growth possibilities over various planning horizons. For example:
  - Bracket current per capita water usage by +/- 20%. If your current PWS water usage is 100 gpcd, assess future demand at 80 to 120 gpcd.
  - Bracket recent population growth by +/- 1% growth. If your recent population growth has been 3%, evaluate future water demand at 2 to 4% growth.

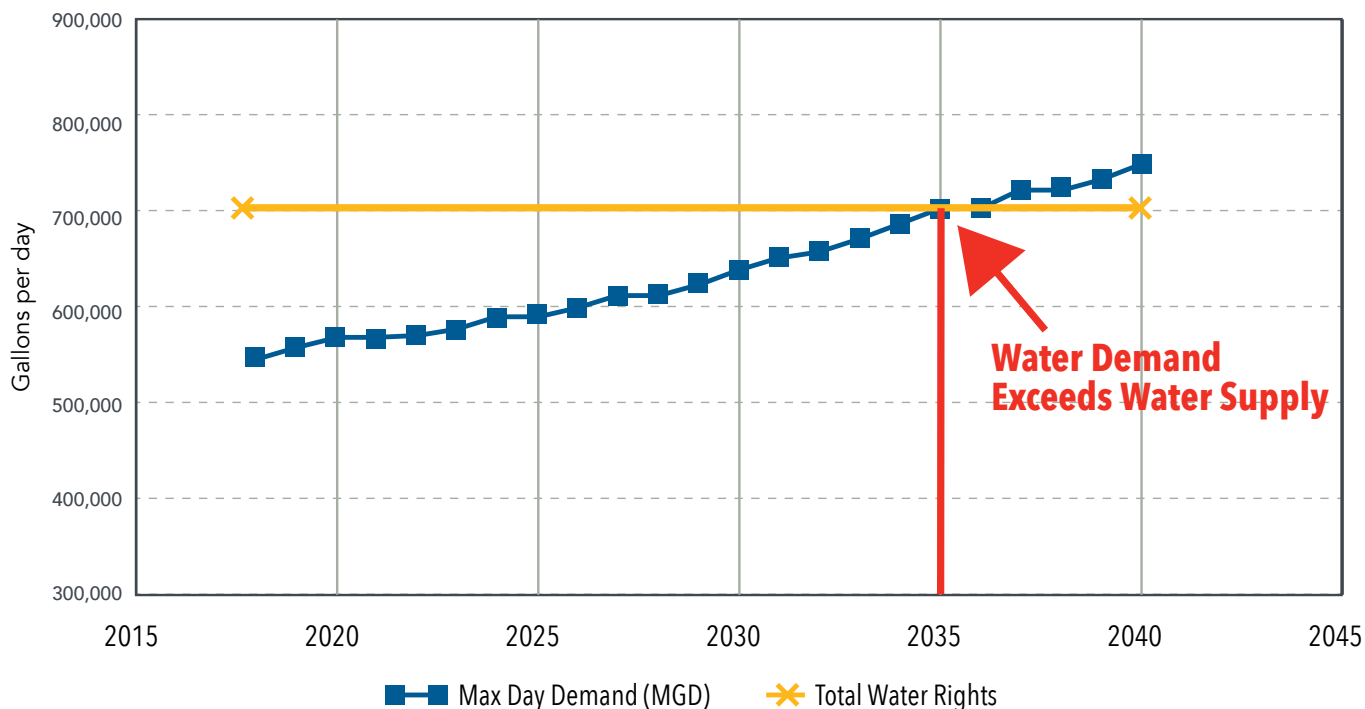
A	B	C	D
YEAR	POPULATION ESTIMATE	MAX DAY DEMAND GPCD	MAXIMUM DAY (MDD)
2020	= 2019 population + (2019 population x Average Growth Rate)	= Average per capita water usage	= BxC
2021			
2022			
2023			
2024			
2025			
2026			

3. Compare the future demand scenarios to future water supply scenarios, with the goal of identifying the potential for a future water shortage.

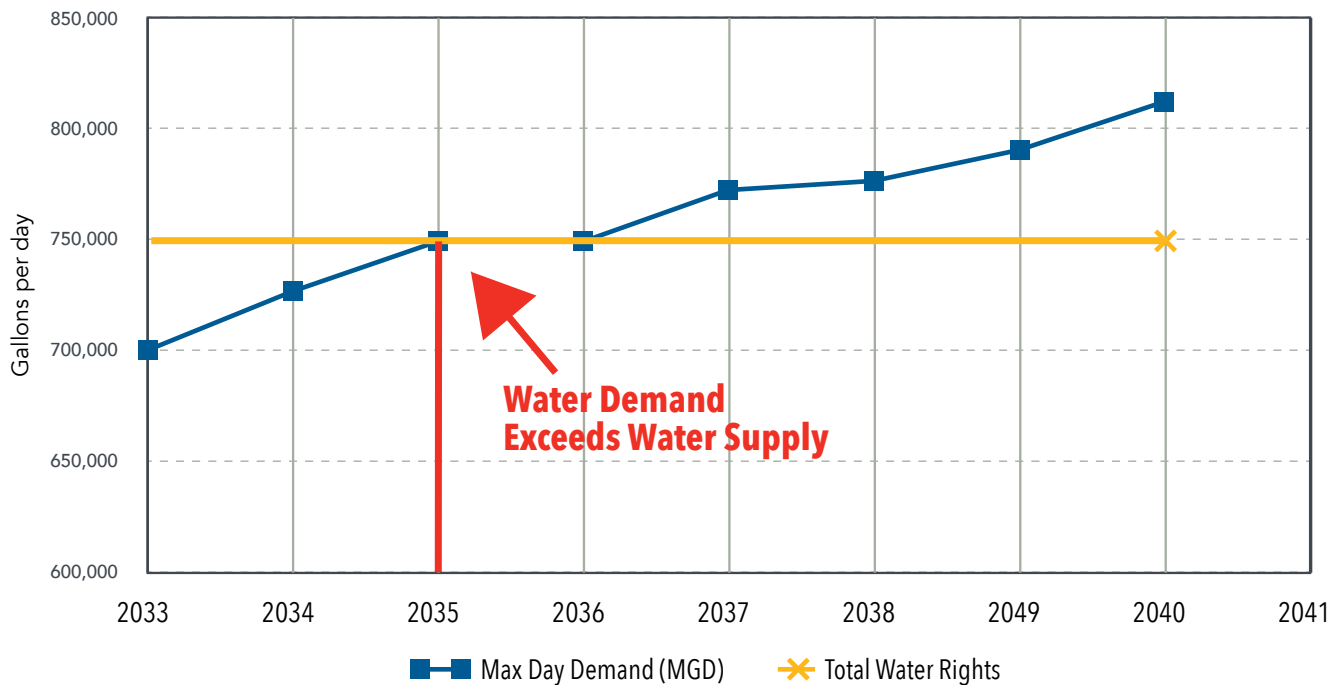
EXAMPLE MAX DAY DEMAND (MGD)



### EXAMPLE WATER SUPPLY SHORTAGE



### EXAMPLE WATER SUPPLY SHORTAGE



### 3.3 FINDING THE RIGHT RATE DESIGN

Deliberate water rate design ensures rates are fair and equitable while providing adequate revenue to meet a water utility's financial objectives. Other important goals of rate design are to develop a rate structure that:

- Is easy to understand and administer.
- Generates a stable revenue stream over time with changing demand.
- Charges customers rates commensurate with the level of service provided.
- Is designed to support the short and long-term objectives of the utility.

There may be other, more nuanced goals for rate structures, such as supporting economic development, providing rate relief for fixed income users, supporting asset management/capital renewal planning, or rewarding water conservation.

Current rate design should be reviewed periodically to determine whether the structure in place is appropriate for the utility's needs. It's helpful to compare water use and/or wastewater discharge patterns of each user class. If there is no clear reason to charge one user differently than another, then a simple rate structure that applies across all classes is appropriate. However, if there are substantial differences in the level of effort and/or cost to provide service to different user classes, then considering a multi-level rate structure is likely warranted.

#### Rate Design Considerations

Rate design entails as much sociology as mathematics, often requiring equal consideration of policy preferences and financial implications:

- Does the current rate structure meet its objectives?
- If conservation is a priority, does the rate structure send a price signal to motivate customers to reduce water use?
- Does the rate structure provide adequate revenue stability, even under conditions of reduced water demand?
- Is the rate structure easy to administer and is it fair?

If a cost of service assessment shows significant disparities between cost percent and revenue percent for some user classes, then it may be worth considering a new rate structure. Rate design should thoroughly consider lifeline rates for low-income customers, conservation, potential economic incentives, and responsible annual reinvestment in the utilities, etc. If the current rate structure is considered fair and equitable and supports both near-term and long-term objectives, slight modifications within the existing structure are likely all that is needed.

Water system charges vary for water supply and delivery services. Most systems use a combination of fixed and volumetric charges. Very few systems charge only a fixed rate or only a volumetric rate. The most common rate structure for very small systems is a flat fee where each account is charged a fixed monthly fee, regardless of the amount of water used.

Many systems use a combination of a flat fee and a volumetric rate structure. The most common examples of volumetric rates are listed below.

- **Declining Block Rate Structure:** Each succeeding block of usage is charged at a smaller unit rate than the previous block(s). This approach is losing popularity for several reasons.
- **Constant Block Rate Structure:** The unit price is consistent, regardless of how much water is used. This is a popular approach and can be used to establish separate volumetric rates for each user class. Class-specific rate adjustments can address equitability – for instance, using lifeline rates for low income households.
- **Inclining Block Rate Structure:** The unit price of each succeeding block of usage is charged at a higher unit rate than the previous block(s). This approach is widely used by systems to promote responsible water use and delay the need for costly water supply and treatment expansion.

Most larger systems have moved away from flat and declining block structures toward constant block and inclining block rate structures. This is due largely to source water availability issues, conservation initiatives, and an overall effort to minimize required capital investment in capacity-related infrastructure. In addition, the declining block structure does not promote efficient water use and funding agencies do not view declining block structures favorably when evaluating funding packages for infrastructure.

### **Inclining Block Rate Structures**

Sometimes referred to as inverted or increasing block, an inclining block rate structure increases cost per unit of water with consumption. The objective is to discourage unnecessary water use by increasing the cost of water that is deemed above and beyond “essential use.” It is often associated with water conservation strategies as it incentivizes a reduction in water use without substantially reducing revenue.

An inclining block rate design generates revenue that reflects the cost of increasing the supply. This rate structure collects adequate revenue from water users who create the need to expand supply. A properly designed inclining block structure will not necessarily increase all customer bills. For those users whose usage is average for the user class and who responsibly irrigate, the cost of water should remain approximately the same or even decrease.

In contrast, users whose irrigation, or non-essential water use, contributes to the community’s maximum water demand will incur higher charges to help pay for the cost of meeting maximum demand. If the user continues to heavily irrigate, the PWS revenue increases to enable the utility to pay for the increased wear and tear on the system, higher pumping costs, and future infrastructure expansion and replacement costs. If the user responds to the pricing signal and reduces their water use, then the PWS will incur less operational and infrastructure expenses because the overall maximum water demand will be reduced.

### **Rate Structure Changes**

Whether considering a change to the rate structure based on conservation goals or for other reasons, there are several issues that a PWS should consider:

- **Educate** the public and governing body on the purpose of conservation rates, their application, and how they will affect billing, etc.
- **Identify** non-economic goals (e.g., resource conservation, growth management) the new rate structure will achieve and convey them to the public and elected officials.





- **Understand** the patterns of use and associated costs of service for each user class. It is important to be aware of these to avoid setting rates that could affect the affordability of water service.
- **Identify** and understand the future costs associated with obtaining additional water supply and treatment capacity.
- **Identify** if there are alternative water sources (e.g., private wells, recycled wastewater for irrigation, etc.) that can significantly impact water revenue.
- **Evaluate** existing metering and billing practices. It is most effective to bill based on actual use rather than estimated use, and monthly billing practices will deliver the price signal more quickly than quarterly or semi-annual billing.
- **Consider** creating a rate stabilization fund to assist in implementing a new structure in the event revenues are reduced.

### **Irrigation Rates**

Many Montana water systems do not charge rates for outdoor watering that are appropriate for the cost associated with providing that water. Encouraging responsible watering is largely a public relations initiative. Montana State University Extension has developed a Yard and Garden Water Management MontGuide with recommendations to encourage responsible outdoor water use. Outdoor water recommendations include:

- Avoid watering in wet or windy conditions
- Utilize drip or soaker hoses, which can reduce evaporation by approximately 60 percent
- Water in the early morning or early evening, when evaporative losses are lowest
- Apply water slowly to avoid runoff and encourage deep root growth
- Do not overwater. Established lawns need approximately 1-2 inches of water every 3-5 days
- Consider the use of timers, rain barrels, xeriscaping, and rain gardens.

## 4.0 OTHER PLANNING APPROACHES

Other planning approaches, including water efficiency, water conservation, drought management, and source water protection can be incorporated into the IWRP process.

### 4.1 WATER EFFICIENCY

Water efficiency refers to reducing water loss (or non-revenue water) by implementing best management practices and improving water distribution infrastructure. Improving water efficiency can reduce water demand, but the infrastructure improvements can be costly. Examples of water efficiency activities and best management practices are summarized below:

#### WATER EFFICIENCY ACTIVITIES AND BEST MANAGEMENT PRACTICES

Improve metering and data collection to better estimate water loss

Install Automatic Meter Reading (AMR) to enable faster identification of leaks

Install submeters for large apartment or condominium complexes to enable demand-based water rate structures

Routinely test meters and replace as needed

Identify unmetered water uses and implement metering

Collect and analyze water use data to identify water efficiency improvement opportunities

Track water use by customer type and structure rates accordingly

Revisit existing water rates and update periodically

Institute tiered rate structures to reward water conservation

Provide incentives for water use efficiency improvements (e.g., rebate programs for more efficient sprinkler systems)

Obtain and routinely update a water audit to track water loss

Implement a routine leak detection and repair program

Replace known leaking or old water mains

Educate ratepayers on the benefits of water efficient plumbing fixtures and appliances and drought tolerant landscaping (xeriscaping) using workshops or newspaper flyers

Update building codes for water efficiency (require water-efficient fixtures in new construction)

Implement irrigation efficiency on PWS owned properties (e.g., Smart Irrigation Controller, high efficiency sprinkler heads, drip systems)

#### Water Audit

PWS water losses are typically attributable to pipeline leaks, billing or metering inaccuracies, data handling errors, or unauthorized consumption/illicit connections. A water audit is an accounting process used to identify non-revenue water. Non-revenue water is the difference between treated water and total water metered that is billed. Water meters must be installed and in working order to conduct a water audit.

Water audits help comprehensively assess a facility's water use and can identify inefficiencies within a water system. Water systems are encouraged to perform a water audit on a regular basis to improve system efficiencies.

The most basic water audits entail comparison of historical treated water quantities to billed / metered water quantities.

Some companies specialize in conducting water audits, but AWWA offers free spreadsheet-based water audit software to help quantify and track water losses associated with water distribution systems at [www.awwa.org](http://www.awwa.org) (search "water loss control.")



## 4.2 WATER CONSERVATION PLANNING

Water conservation encompasses specific strategies, policies, and regulations to manage water resources and ensure sustainable water supplies for current and future demand.

Water conservation can benefit customers by reducing future increases in water and wastewater rates.<sup>3</sup> When water use declines, costs to the PWS can be reduced because infrastructure, operating costs, and the cost of attaining future supplies are reduced. These savings can be considered in future rate structure design.

*Water conservation strategies typically target the following areas:*

- **Water system and utility** strategies include developing a conservation program, conservation-minded water rates, controlling system's water loss, enacting a water waste ordinance, developing an outdoor irrigation strategy, and public information and education programs.
- **Commercial and industrial** examples include outdoor irrigation efficiency, pool maintenance and leak reduction, reduction of water-cooled air conditioning, and landscape watering restrictions.
- **Outdoor irrigation** strategies include irrigation system improvements, water efficient landscape designs, and smart irrigation controllers.
- **Indoor residential** examples include high efficiency fixture and appliance incentives, rebates for replacement of inefficient water fixtures and appliances, rules for new construction, and water use audits.

Water conservation plans can be developed as part of the Integrated Water Resources Planning process but are not required.

*Water conservation can help:*

- Improve efficiency of existing facilities to extend service life.
- Postpone or decrease the need for capital projects that increase capacity.
- Improve drought or water shortage preparedness.
- Minimize costs for new source development.
- Educate customers about the value of water.
- Improve water system reliability.
- Protect and preserve environmental resources.



<sup>4</sup> Feinglas, S., Gray, C., & Mayer, P. (2013). *Conservation Limits Rate Increases for a Colorado Utility*. Alliance for Water Efficiency, Chicago.

## 4.3 DROUGHT MANAGEMENT PLANNING

Drought is a feature of Montana’s climate that has historically impacted and will continue to impact all water use sectors in all corners of the state.

Drought management planning consists of developing effective strategies and operations to manage water demand during drought-related water shortages. There are many easily accessible resources to guide drought management planning. The Bureau of Reclamation Drought Response Program Framework is an excellent guide and breaks drought planning down into the following components:

### Drought Monitoring

Monitoring drought conditions enables a PWS to recognize a drought in its early stages and accurately assess its severity over time in order to act. The City of Bozeman adopted its drought management plan in 2017 and uses an application-based spreadsheet to track local and national drought indices that correspond to a drought response stage.

### Vulnerability Assessment

It is important to consider a public water system’s vulnerability to drought, as vulnerabilities vary based on the source of water, location, climate and diversity of water sources. For example, surface water supplies are generally more vulnerable to short-term drought than groundwater supplies, which usually have some buffering capacity for short-term drought impacts. Conversely, aquifers may take longer to recover from longer-term drought than surface water. Increasingly, communities are assessing potential climate change impacts as part of vulnerability assessments.

### Adaptation Actions

Once communities identify potential impacts from drought, they should brainstorm, vet, and institutionalize potential ways to enhance community and ecosystem resilience to future droughts. Adaptation refers to projects or programs implemented before drought occurs that help reduce potential impacts during drought. Adaptation actions can range from additional water source development and related infrastructure improvements to policy actions such as passing an ordinance to encourage xeriscaping. Examples of drought adaptation strategies are shown in the table on the next page.



CATEGORY	DESCRIPTION
<b>Policy Level Planning</b>	<ul style="list-style-type: none"> <li>• Continue to develop and advocate for policy improvements</li> <li>• Develop cooperative sharing agreements with local water users to implement during periods of drought, which may involve exchanges, trades or agricultural leases.</li> <li>• Implement a policy whereby developers of subdivisions desiring annexation must provide adequate water rights or accepted offsets.</li> </ul>
<b>Improve Water Distribution Efficiency through New and Existing Operations and Maintenance Activities</b>	<ul style="list-style-type: none"> <li>• With the addition of new supplies, modify system operations to optimize efficiency of overall distribution system and monitor current operational practices to improve efficiency where possible.</li> <li>• For existing supplies, optimize water treatment plant operations to increase efficiencies.</li> <li>• Use pressure zone specifications for new development.</li> <li>• Routinely detect and repair leaks. Monitor and replace inaccurate meters.</li> </ul>
<b>Reduce Water Demand/Encourage Conservation</b>	<ul style="list-style-type: none"> <li>• Continue to promote water conservation via education, rebates and other incentives.</li> <li>• Pursue non-potable irrigation projects.</li> <li>• Develop rate structures that factor in water conservation/water shortage conditions.</li> </ul>
<b>Develop New or Redundant Water Supplies</b>	<ul style="list-style-type: none"> <li>• Evaluate alternatives to increase water supplies as applicable.</li> <li>• Analyze costs and water supply yield of alternatives.</li> </ul>
<b>Maximize and Protect Existing Supplies</b>	<ul style="list-style-type: none"> <li>• Evaluate operational practices to improve and optimize water supplies.</li> <li>• Replace or repair existing infrastructure to stop water leakage and reduce water loss.</li> <li>• Develop or update a Source Water Protection plan.</li> </ul>



## Response Actions

While adaptation actions occur before a drought, response actions occur during or after a drought to address impacts. Response actions are triggered during specific stages of drought to manage limited water supply and decrease the severity of immediate impacts. Reducing water use as part of a drought stage declaration is a typical response action. Ordinances may limit outdoor watering and impose fines on those who fail to comply with the ordinance. Example response actions are shown in the table below.

ELEMENT	STAGE 1	STAGE 2	STAGE 3	STAGE 4
	DROUGHT WATCH CUSTOMER OUTREACH	DROUGHT ADVISORY MANDATORY RESTRICTIONS	DROUGHT WARNING BAN ON LAWN WATERING	DROUGHT EMERGENCY RATIONING
<b>Outdoor Watering</b>				
<b>Turf grass</b>	No restrictions	Two days / week per mandatory schedule based on customer class and address	No watering permitted	No watering permitted
<b>New seed and sod</b>	Permitted with exemption signage for establishment	Permitted with exemption signage for establishment	No watering permitted	No watering permitted
<b>New plantings</b>	Permitted	No installations from June-August	Not permitted	Not permitted
<b>Trees, shrubs, perennials</b>	Water efficiently	May be watered by hand-held hose or low-volume non-spray irrigation on any day, not between 10 a.m. and 6 p.m.	Existing trees and shrubs may be watered by means of a hand-held hose or low-volume non-spray irrigation no more than once per week on scheduled day	Not permitted, or use of hand-held hose or low-volume spray may be limited to no more than one assigned day per month
<b>Flowers, vegetables, and community gardens</b>	No restrictions	May be watered by means of a hand-held hose or low-volume non-spray irrigation on assigned watering days, not between 10 a.m. and 6 p.m.	May be watered by means of a hand-held hose or low-volume non-spray irrigation on assigned watering days, not between 10 a.m. and 6 p.m.	No watering permitted
<b>Athletic and playing fields</b>	No waste of water	Irrigated per mandatory scheduling or water budget restrictions	Irrigated per mandatory scheduling or water budget restrictions	No watering permitted
<b>Golf courses</b>	No waste of water	Irrigated per mandatory scheduling or water budget restrictions	Trees and greens only	No watering permitted

*Example ordinance language to reduce water use:*

**AUTHORITY TO RESTRICT OUTDOOR USE OF WATER**

The director of public works is, with the concurrence of the city manager, authorized, directed and empowered, whenever in the director's opinion the necessities of the situation demand such action, to restrict or wholly prohibit the outdoor use of the water supply of the water service utility.

**RESTRICTION OF PARTICULAR INDOOR USES**

Whenever outdoor use restrictions are in effect, business establishments which serve beverages for human consumption shall be prohibited from serving water except upon request.

**SPRINKLING SYSTEMS; TIMING**

Whenever outdoor use restrictions are in effect, the director of public works may set alternative time restrictions for the use of large-scale sprinkling systems or those which are equipped with a timing device.

**NOTICE REQUIRED**

Restrictions or prohibitions imposed by the director of public works shall become effective at midnight immediately following the publication of notice thereof in any daily newspaper published in the city.

**WASTING WATER PROHIBITED**

Whenever outdoor use restrictions are in effect, no person shall waste water which shall include but not be limited to permitting water to escape or run to waste.

**PENALTIES**

Any person who violates this division or the restrictions issued hereunder shall be deemed guilty of a misdemeanor and upon conviction thereof shall be fined in an amount not less than \$100.00 or more than \$500.00.



## Operational and Administrative Framework

An operational and administrative framework identifies roles and responsibilities for each element of a drought management plan, including public outreach tasks. At a minimum, the framework should identify roles, responsibilities, and procedures necessary to initiate response actions. Examples of operational framework and public outreach are shown below.

MEMBER NAME	ORGANIZATION	TITLE	DROUGHT TEAM FUNCTION	RESPONSIBILITIES	PHONE NUMBER	EMAIL ADDRESS
			Drought Plan Coordinator	Manage the Drought Team and the Drought Plan		
			Public Works Coordination	City Commission Drought Plan liaison. Direct oversight of PW divisions		
			Water Distribution Impacts and Response, Leader of City Water Crews	Coordinate water distribution activities and utilize crews for monitoring water use during drought		
			Water/Wastewater Infrastructure Contact	Support coordination of the Drought Plan		
			Parks and Recreation Coordinator	Manage City Parks and Recreation water usage and responses to drought stages		
			Disaster and Emergency Services Contact and Coordination	Disaster and emergency coordination and drought communications coordination		
			Water Treatment Plant Operations	Monitor and report water supply and demand information		
			Law Enforcement	Enforcement of violations in severe drought stages		



TARGET AUDIENCE	MESSAGING TOOLS	
	LONG TERM MITIGATION	SHORT TERM RESPONSE
Commission / Utility Departments and Divisions	<ul style="list-style-type: none"> <li>• Email</li> <li>• Meetings</li> </ul>	<ul style="list-style-type: none"> <li>• Email</li> <li>• Meetings</li> <li>• Special Presentations</li> </ul>
Water Customers (Single Family, Multi Family, Commercial)	<ul style="list-style-type: none"> <li>• Website</li> <li>• Social networking</li> <li>• Media</li> <li>• Workshops</li> </ul>	<ul style="list-style-type: none"> <li>• Website</li> <li>• Social networking</li> <li>• Newspaper articles</li> <li>• Interviews</li> <li>• Public Meetings</li> <li>• Special Presentations</li> </ul>
Targeted Business Owners and Institutional Users	<ul style="list-style-type: none"> <li>• Website</li> <li>• Social networking</li> <li>• Media</li> <li>• Special Presentations</li> <li>• Meetings</li> </ul>	<ul style="list-style-type: none"> <li>• Website</li> <li>• Mailers</li> <li>• Meetings</li> <li>• Special Presentations</li> </ul>
Large Water Users	<ul style="list-style-type: none"> <li>• Direct Mailers</li> </ul>	<ul style="list-style-type: none"> <li>• Direct Mailers</li> <li>• Special Presentations</li> </ul>
Commercial Business Employees	<ul style="list-style-type: none"> <li>• Presentations</li> <li>• Meetings</li> </ul>	<ul style="list-style-type: none"> <li>• Presentation</li> <li>• Meetings</li> </ul>
Schools	<ul style="list-style-type: none"> <li>• Water education curriculum for teachers</li> <li>• Water education for teachers</li> <li>• Special presentations</li> </ul>	<ul style="list-style-type: none"> <li>• Special Presentations</li> </ul>

### Plan Update Process

The Bureau of Reclamation's drought management guide recommends having a clear plan for updating the drought management plan over time to ensure that it evolves with growth projections and/or other changes in supply or demand.

### Drought Rate Surcharges

Water pricing can be an effective tool to reduce demand during times of drought. Drought surcharge rates are carefully developed to maintain adequate revenue to meet system revenue requirements when water sales decline. Inclining block rates, seasonal rates, drought surcharges, or excessive use surcharges are also identified as drought adaptation tools. A tiered rate structure that charges water utility customers more for higher than basic water use can be used. Public water systems that are particularly vulnerable to drought (e.g. only surface water sources), might consider a more aggressive approach - typically involving the use of drought rate surcharges.

A rate surcharge is a separate charge added to existing rate structures to collect either a targeted amount of revenue or to assess an appropriate charge for a given use beyond those covered in the basic charge for service. Surcharges are often presented separately from the existing rates and labeled for the specific purpose/event the funds will help address. Drought surcharges are often used on an emergency and temporary basis to pay for costs associated with purchasing emergency water supplies during a severe drought or to support drought restrictions.

Outdoor watering is a primary target for reductions via drought surcharges. Consideration is also given to usage characteristics and associated with different types of users. It is important to evaluate water use factors in a community when setting surcharge rates to understand how to best effect changes to discretionary water use.

*The table below summarizes various types of surcharges.*

SUMMARY OF TYPES OF DROUGHT SURCHARGES		
TYPE OF DROUGHT SURCHARGE	DESCRIPTION	EXAMPLE
<b>General Rate Adjustment</b>	Implement a drought surcharge on all service rates.	All volume rates increased by a specific percentage estimated to yield an acceptable level of demand reduction.
<b>General Volumetric Surcharge</b>	Surcharges applied based on volumetric use. Identifies cost impacts of using water during droughts.	<ol style="list-style-type: none"> <li>1. Uniformly applied surcharge over all consumption blocks.</li> <li>2. Surcharge applied to consumption beyond a specific level.</li> <li>3. Graduated increases in surcharge as consumption increases.</li> </ol>
<b>Class-Based Volumetric Surcharge</b>	Establish quantity limits based on classes of users and apply a surcharge to users exceeding the limit for that class.	Volumetric surcharge by customer class of service.
<b>Individualized Volumetric Surcharge</b>	Apply surcharges to users based on their water demand exceedance of a specified percentage of base period water use.	A 25% surcharge applied to any customer using greater than 80% of their average demand during base period.
<b>Targeted Volumetric Surcharge</b>	Target certain classes that have more discretionary use for greater surcharges than others.	Implement a high surcharge on residential outdoor usage and a lower surcharge to hospitals or public schools.

Drought management must include monitoring and assessing current drought conditions that translate to an overall drought stage. The primary goal of a drought monitoring plan is to recognize a drought in its early stages and accurately assess its severity over time, in order to trigger and implement appropriate responses.

Having a transparent, quantifiable, and scientific basis for drought declaration is critical for timely decision-making, effective communication with officials, and managing expectations of the public. A drought monitoring plan enables a PWS to react quickly, implement appropriate restrictions early, and make allowances for different types of uses and needs of different water users.



## 4.4 SOURCE WATER PROTECTION PLANNING

Source Water Protection planning is a collaborative process that consists of developing strategies to protect drinking water supplies from contamination. Proper delineation and assessment of threats to drinking water supplies helps inform source water protection strategies.

*Source water protection should consider various water uses within a watershed. Potential uses may include the following:*

- Drinking water supply
- Recreation
- Wildlife habitat
- Housing development
- Agriculture
- Industrial use
- Power generation
- Wastewater treatment and disposal

It is important to organize a watershed planning team with representatives from various interest groups to help develop a source water protection plan. A source water assessment includes identifying businesses, activities, or land uses within a source water protection area to determine the potential for contamination from these sources. Steps to complete a source water assessment include:

- Identify water supply sources and delineate the surrounding area
- Identify and inventory potential sources of contamination
- Assess the susceptibility of the source water area to contamination

A Source Water Delineation and Assessment Report (SWDAR) exists for every PWS in Montana. These reports are available on MT DEQ's website. Many reports were completed in the early 2000s and can provide a good starting point for assessing current potential contaminants.

*An example flowchart summarizing the procedures for developing a source water protection program shown on right.*

### SAMPLE SOURCE WATER PROTECTION PLAN



*Some examples of management approaches to protect water sources include:*

- Regulations, bylaws, ordinances
- Enforcement actions
- Land acquisitions
- Monitoring
- Emergency response plans
- Herbicide-pesticide application restrictions
- Stormwater management
- Road-salting restrictions
- Public education
- Recreation access restrictions
- Agricultural Best Management Practices (BMPs)

Completed source water protection plans should be submitted to MT DEQ for review and certification every five years. Certified plans are helpful to secure funding for implementation. Successful source water protection planning can provide information to improve raw water quality and help identify water quality issues and risk mitigation strategies.

More information is available in the Montana Source Water Protection Technical Guidance Manual which may be available by contacting [Montana Rural Water Systems](#). Montana Rural Water Systems (MRWS) is a non-profit association that offers training and technical assistance – including source water protection planning and implementation – to rural water/sewer districts, homeowners associations, cities and towns, mobile home parks, schools and campgrounds throughout the state.

*Montana Rural Water Systems' Goals include:*

- Help ensure an adequate supply of safe drinking water for all Montanans.
- Assist water/wastewater systems in complying with regulations pertaining to the Safe Drinking Water and Clean Water Acts.
- Train and inform managers, operators, bookkeepers, board members, and city officials in order to improve the operation and management of water/wastewater systems.
- Conduct over 20 free training sessions for operators, clerks/bookkeepers and administrative personnel.
- Assist systems in obtaining adequate funding to improve/expand existing systems or to construct new plants.

Technical staff consist of a Training Specialist, Water Circuit Rider, Wastewater Technicians, and Source Water Specialists. The Training Specialist plans and organizes all training sessions and provides technical assistance as needed. Water Circuit Riders and Wastewater Technicians travel throughout the state providing information and technical assistance, including leak detection and rate structuring, to those responsible for the proper maintenance and operation of the system. Source Water Specialists aid in developing and implementing “Source Water Protection Plans” for communities and water districts.

## 5.0 CONCLUSION

Integrated Water Resources planning (IWRP) and management is a continuous process to support water management at the local, county or regional scales. For public water utilities, the planning process evaluates supply and demand issues while considering utility, community, and environmental input. This approach should incorporate a decision-making process with participation from affected stakeholders. Benefits of public involvement throughout the planning process include:

- Understanding and addressing the public's concerns.
- Increasing public access to accurate information and communicating water quality and water quantity issues more effectively.
- Increasing public support for the PWS.

A public water system can complete parts of the IWRP process or develop a detailed, comprehensive plan depending on available resources and planning objectives. The main components of the IWRP process include:

- **Water Supply** – Assessing water supply and supply monitoring strategies to provide guidance for future water resource management. First steps include water supply and water rights evaluations along with a vulnerability assessment.
- **Water Demand** - Understanding water demand and defining water use patterns by processing historical water demand data helps forecast future water demand and outline potential needs for new water supplies or infrastructure.
- **Other Planning Approaches** - Other planning strategies including water use efficiency / water conservation, drought management, and source water protection may provide additional benefit.



## 6.0 REFERENCES

Wherever possible we have included digital links for the resources below.

### 6.1 Integrated Water Resources Planning

*Water Resources Planning. AWWA Manual M50 (2017, 3rd Edition).* AWWA's Integrated Water Resources Planning resource for purchase provides an overview of water resources planning and a summary of a general water resources planning methodology.

An excellent overview of the document can be found at this link. [M50-3lookinside.pdf](#)

This resource provides an overview of water resources planning, including emphasis on policies, legal issues (water rights), and descriptions of various water resources (including demand management).

This resource also provides a good explanation of water demand forecasting models, a background on water quality issues, source water protection recommendations, and how to assess water supplies. The final chapter provides recommendations on developing an Integrated Water Resources Management Plan.

- *Palmer, Richard N., and Kathryn V. Lundberg. Integrated Water Resources Planning.*

This free document served as the basis for AWWA's first Integrated Water Resources Planning resource and provides a good overview of the IWRP process and a summary of a general water resources planning methodology. *Sections include:*

- Advantages of IWRP
- History and Characteristics of Water Resources Planning
- Public Involvement
- Water Demand Forecasting
- Water Supply Reliability Evaluation
- Source Strategies
- Developing Resource Portfolios
- Drought Contingency Planning
- Emergency Planning and Vulnerability Assessment
- Modeling the IWRP Process

### 6.2 Water Demand Forecasting

- *Water Research Foundation Demand Forecasting Weekly to Long-Term Forecasts are Essential for Operations and Planning. Fact Sheet April 2017*
- *US EPA Water Conservation Plan Guidelines: Part 3 Basic Guidelines April 1998*

### 6.3 Vulnerability Assessment

- *EPA Vulnerability Risk Assessment Tool*
- *US Environmental Protection Agency web-based software application tool titled Climate Resilience Evaluation and Awareness Tool (CREAT)*

### 6.4 Drought Management

- *Managing Water in the West. Drought Response Program Framework: WaterSMART Program. U.S. Department of the Interior, Bureau of Reclamation, May 2015*
- *Alliance for Water Efficiency Resource Library Drought and Drought Response*
- *Bozeman Drought Management Plan*
- *Colorado Water Conservation Board Local Drought Planning*

### 6.5 Water Conservation

- *US EPA Water Conservation Plan Guidelines April 1998*
- *City of Bozeman – Water Conservation*

### 6.6 Water Use Efficiency

- *WaterWise, Colorado. Guidebook of Best Practices for Municipal Water Conservation in Colorado. Denver, CO: Colorado WaterWise (2010)*
- *Colorado Water Conservation Board. Municipal Water Efficiency Plan Guidance Document. July 2012*

### 6.7 Water Audit

- *AWWA Water Loss Control Resource Community*
- *Alliance for Water Efficiency Water Audit Process Introduction*

### 6.8 Source Water Protection Planning

- *Montana Source Water Protection Technical Guidance Manual (MBMG 1998)*
- *Montana Rural Water Systems Source Water Protection Planning Technical Assistance*

### 6.9 Current Conditions Monitoring

#### Precipitation

- *National Weather Service Climate Prediction Center*

#### Snowpack

- *NRCS – Montana Snow Survey*

#### Streamflow

- *USGS Current Water Data for Montana*
- *Montana DNRC Stream Gage Program (Stream and Gage Explorer)*

#### Reservoir Levels

- *Bureau of Reclamation – MT Lakes and Reservoirs*
- *Montana State Library – Reservoir Levels*
- *Montana DNRC Water Projects*