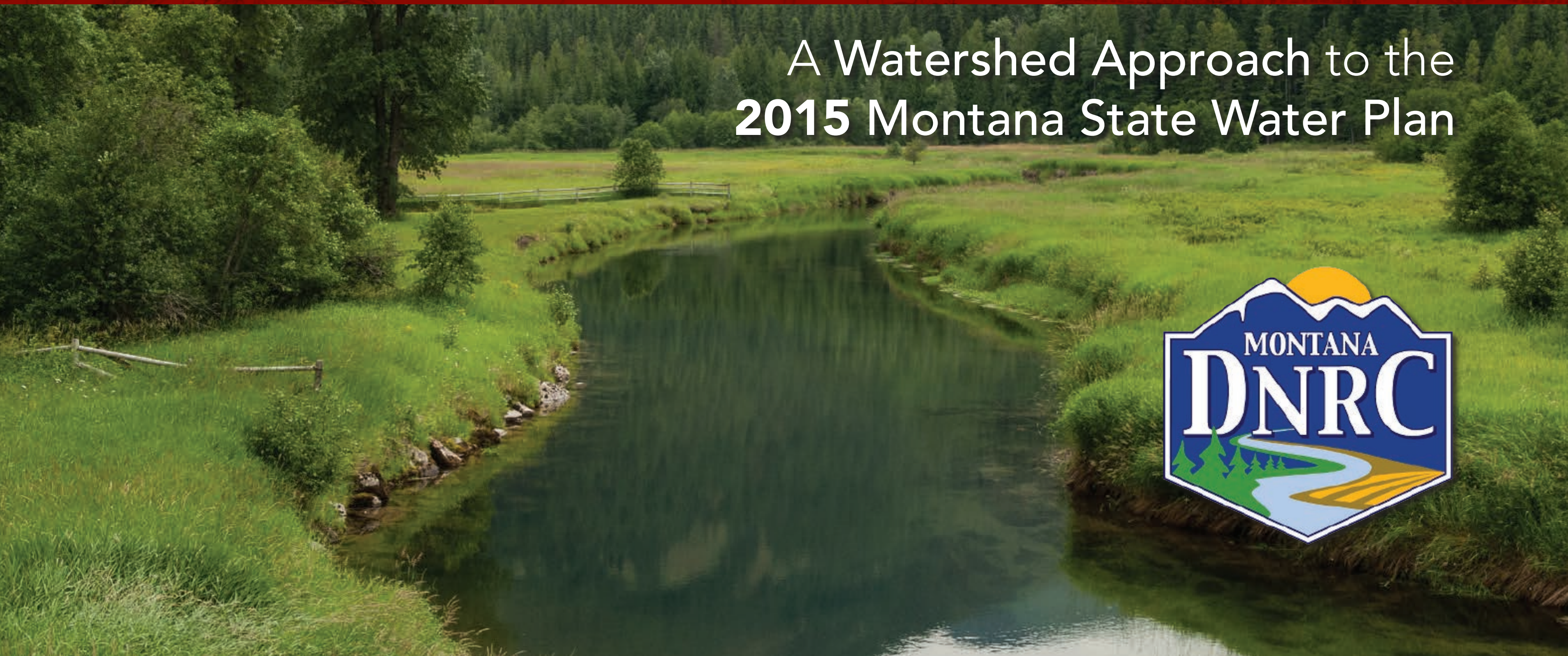
Montana State Water Plan



A Watershed Approach to the
2015 Montana State Water Plan

MONTANA
DNRC

MONTANA DEPARTMENT OF NATURAL RESOURCES AND CONSERVATION

December 5, 2014

My Fellow Montanans,

Montana's economy and quality of life rely on water for everything from agriculture, livestock, fisheries, recreation, hydropower, industry and municipal uses. Montana enjoys the benefits of being a headwaters state where mountain snowpack delivers high quality water supplies into our valleys and plains. Balancing competing water demands with uncertain future water supplies is required. The State, working with citizens across Montana, must proactively plan and implement efforts to achieve a balance that ensures a strong economy and protects the magnificent environment we all enjoy and rely upon. It is with this recognition of the importance of water to the people of Montana that the Department of Natural Resources and Conservation (DNRC) is proud to adopt the 2015 State Water Plan.

The 2015 Montana State Water Plan contains sixty-eight recommendations intended to guide state water policy and management over the near, intermediate and long-term bases. All recommendations contained in the State Water Plan are guided by the legal principles in the Montana Constitution, the prior appropriation doctrine and the Montana Water Use Act.

During the 18-month long planning process, DNRC worked with four regional Basin Advisory Councils (BACs) representing water users in the Clark Fork/Kootenai, Upper Missouri, Lower Missouri and the Yellowstone river basins. The 80 members of the four BACS represent the most diverse group of water users and interests ever brought together by the State of Montana. I want to thank all the members of the BACs for their hours of service in developing the basin plans that are the bases for the State Water Plan.

The planning process also benefited from the hundreds of Montanans who took the time to provide the BACs and the DNRC with comments on what they feel are the key water related issues facing Montana and how we, as a state, can address them together. As a result, the recommendations offered in the State Water Plan reflect the collective work and ideas of a broad range of water users from across the state.

I believe that implementation of the recommendations offered in the State Water Plan will provide the state and people of Montana with the information and tools necessary to meet the complex challenges of managing this vital resource to meet current uses and needs of future generations who will call Montana home.

Sincerely,

John E. Tubbs, *Director*

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Montana Department of Natural Resources and Conservation

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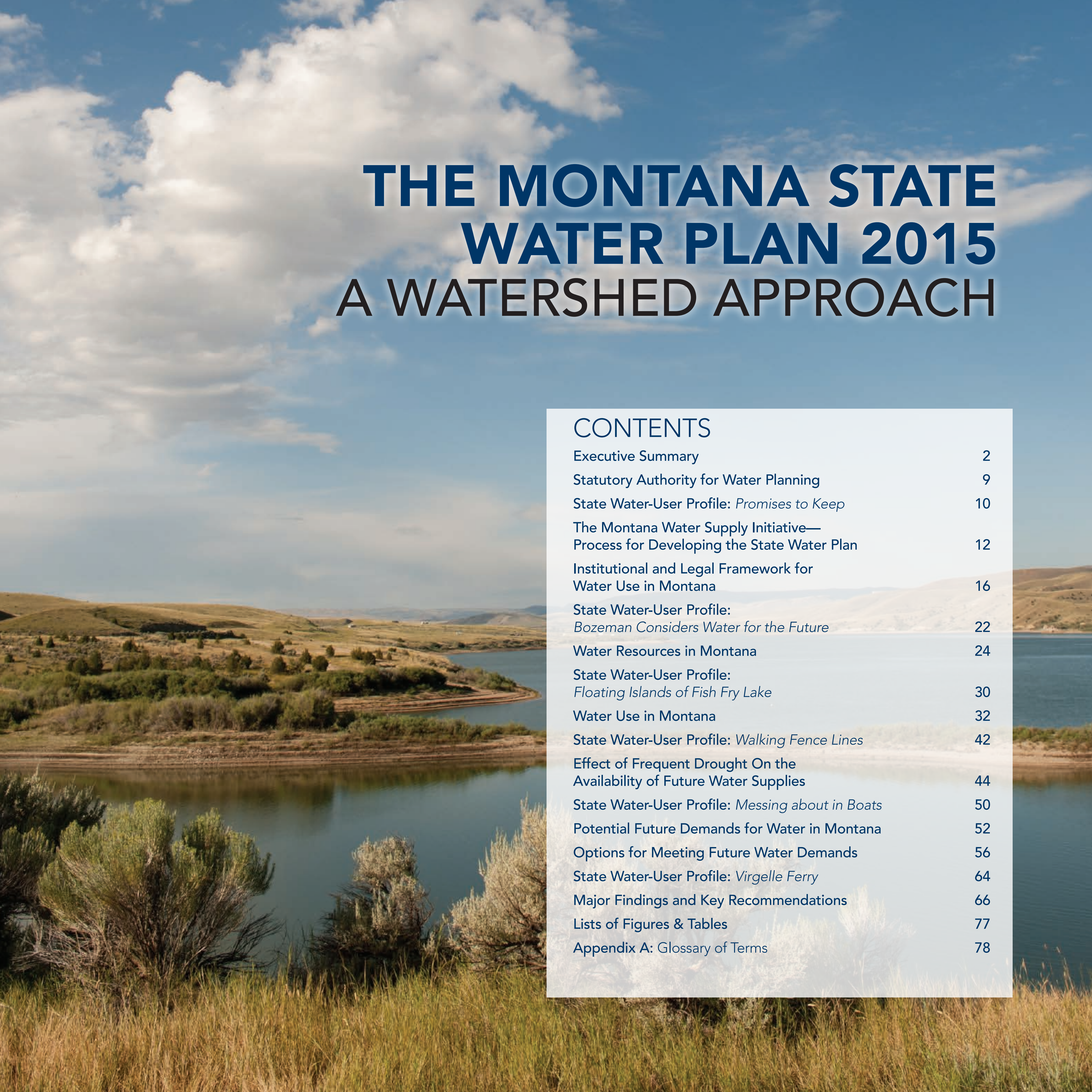

THE MONTANA STATE WATER PLAN 2015

A WATERSHED APPROACH

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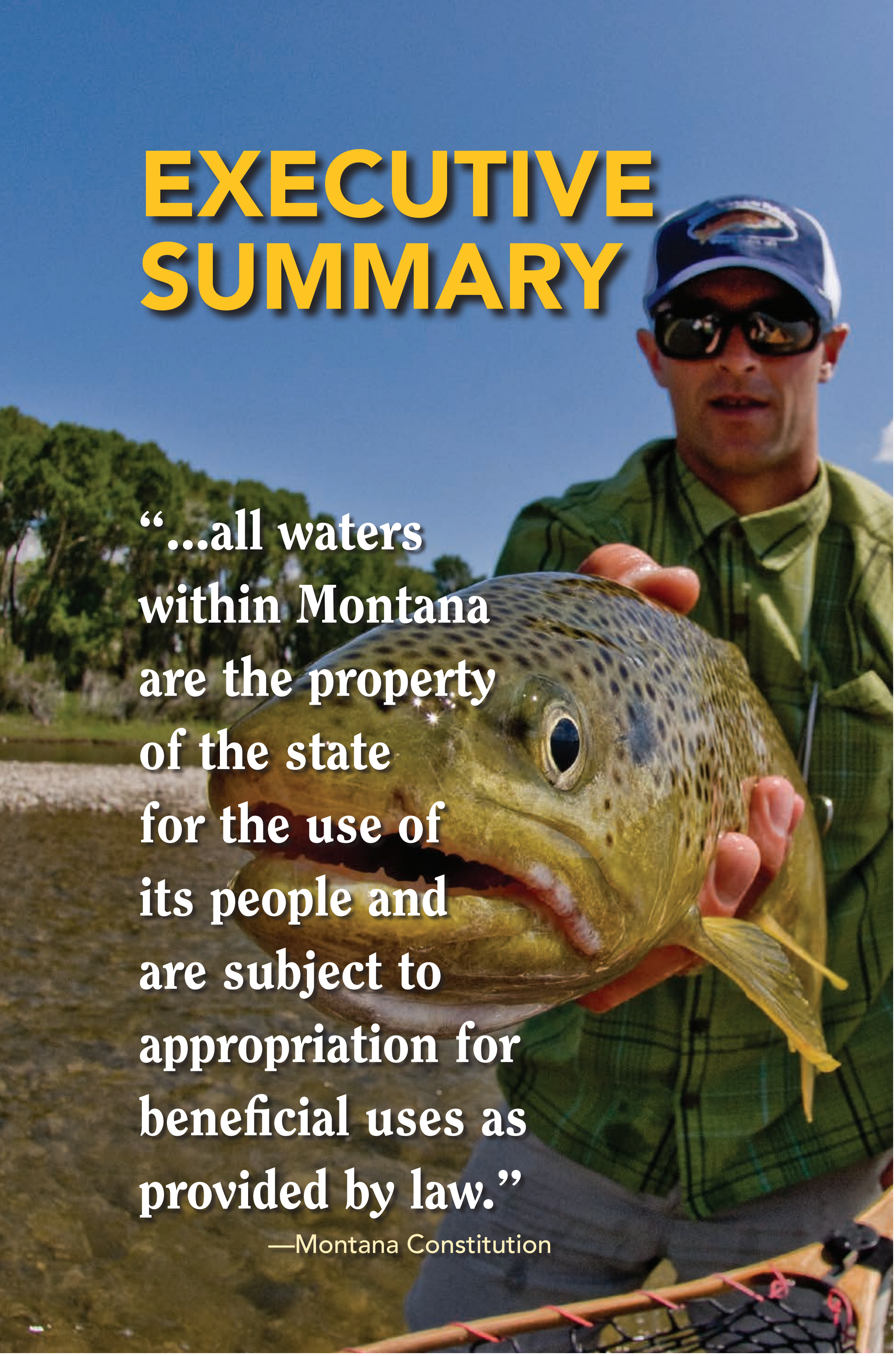


EXECUTIVE SUMMARY

"…all waters within Montana are the property of the state for the use of its people and are subject to appropriation for beneficial uses as provided by law."

—Montana Constitution

Montana's economy and quality of life rely on water for everything from agriculture, livestock, industry, fisheries, and recreation, to municipal and domestic uses. It is with this recognition of our dependence on water that the Department of Natural Resources and Conservation (DNRC) is proud to present the 2015 State Water Plan to the Montana Legislature and the citizens of Montana.

The 2015 State Water Plan is a synthesis of the vision and efforts of regional Basin Advisory Councils (BACs) established in Montana's four main river basins: the Clark Fork/Kootenai, Upper Missouri, Lower Missouri, and the Yellowstone. The 80 members of the four BACs represent one of the most diverse groups of water users and interests ever brought together by the state of Montana. As part of the planning process, the BACs and DNRC were assisted by the hundreds of Montanans who took the time to provide the BACs and the DNRC with comments on what they feel are the key water related issues facing Montana and how we, as a state, can address them together.

As a result, the recommendations in the State Water Plan reflect the collective work and ideas of a broad range of water users from across the state. We believe that if the state and people of Montana carry out the recommendations offered in the State Water Plan, then Montana in the next 20 years will:

- Have finalized the adjudication of all water rights in the state of Montana – an effort that began in 1973;
- Be better prepared to manage water in real-time to adjust to seasonal changes in supply and demand as well as prepare for longer term climatic changes;
- Be better able to protect existing

and senior water right holders while continuing to improve the state's ability to allocate water to meet new demands;

- Be better prepared to endure droughts in watersheds across the state;
- Be better able to supply water to serve the needs of a growing population and thriving economy as well as the natural systems, habitats, and species that our state is renowned for; and
- Have a public that better understands the dynamics of our water supply and the water rights system they rely upon every day.

The Montana Legislature directed DNRC to update the State Water Plan and submit the results to the 2015 Legislative Session. The State Water Plan is to include:

- An inventory of consumptive and nonconsumptive uses associated with existing water rights;
- An estimate of the amount of surface and groundwater needed to satisfy new future demands;
- Analysis of the effects of frequent drought and new or increased depletions on the availability of future water supplies;
- Proposals for the best means, such as an evaluation of opportunities for storage of water by both private and public entities, to satisfy existing water rights and new water demands;
- Possible sources of water to meet the needs of the state; and
- Any legislation necessary to address water resource concerns.

The guiding legal principles for the State Water Plan include: the Montana Constitution with its recognition of pre-1973 water rights and the fundamental principles of the prior appropriation doctrine ("first in time is first in right"); and, the Montana Water Use Act that, amongst other things, governs the adjudication of existing pre-1973 water rights, new appropriations of water, changes to existing water rights, water rights compacts, water reservations, and water planning.

During the 18-month long planning process, DNRC worked with the BACs on developing basin specific responses to each of the subject areas listed above. Results of this effort in each planning basin, along with supporting data, are contained in four individual basin planning reports. Each of the four basin plans serves as a standalone document for guiding the development and management of the basin's water resources.

These basin plans will continue to evolve to meet the planning needs of their respective basins.

In contrast to the detail rich basin plans, the State Water Plan provides a high-level overview of the state's water resources and lays out a path for managing those resources over the next twenty years. Although the State Water Plan represents the outgrowth of these regional plans, only the State Water Plan has been formally adopted by DNRC. In the event that guidance in one of the basin plans is at odds with the State Water Plan, the direction offered in the State Water Plan takes precedence. Similarly, the policy recommendations offered in the basin plans represent the collective work of the individual BACs and should not be interpreted as carrying the authority of official state policy. The basin plans are all available for review at www.dnrc.mt.gov/mwsi.

Water use in Montana totals approximately 84 million acre-feet annually. Hydroelectric power generation accounts for 72 million acre-feet or 86% of the water used on a state-wide basis. Approximately 3.6 million acre-feet are consumed state-wide. Agriculture diverts approximately 10 .4 million acre feet and consumes approximately 2.4 million acre-feet, reservoir evaporation consumes 1 million acre-feet, and municipal, industrial, domestic, and livestock watering consume approximately 200,000 acre-feet combined.

Demand for water is a function of many factors that are inherently uncertain. Population may grow or decline and agriculture and industry may demand more water or make do with less through greater efficiency. Changing and variable climatic conditions compound this uncertainty.

To forecast the potential effects of climate trends on future water supplies in Montana, DNRC modeled a range of climate scenarios following general procedures similar to those described in the U.S. Bureau of Reclamation (2011) West-Wide Climate Risk Assessments. Virtually all model simulations project warmer temperatures and most project modest precipitation increases. Although annual stream flow volumes are expected to stay the same or increase, Montanans are likely to see a shift in the timing of runoff due to earlier snowmelt and an increase in rain as a percentage of precipitation during late winter and early spring.

The availability of water for new appropriations varies across the state and is subject to both physical water availability and existing legal demands. Many of the basins located in the western third of the state are generally closed to new surface water appropriations. Opportunities for new appropriations for surface water or hydraulically connected groundwater also may be limited outside of closed basins because of existing legal demands including irrigation claims, hydroelectric rights, or instream water rights for fisheries, wildlife, and recreational use.

Given the scarcity of legally available surface water, the reallocation of existing water rights to new uses will play a key role in meeting future demands. As part of that reallocation, water users must receive an authorization from DNRC before they change or lease their water right in order to ensure that they will not adversely affect other water rights.

In areas of Montana, the ability to put water to a beneficial use is limited as much by water quality as physical availability. Water quantity and water quality are closely intertwined and the Montana Water Use Act recognizes this relationship (§85-2-311 MCA). However, this document offers limited guidance regarding water quality issues because DNRC has no authority to regulate water quality and the state water planning statute does not explicitly address water quality. The Department of Environmental Quality has primary authority over the regulation of water quality in Montana. For more information on water quality regulation in Montana, please reference DEQ's Montana Nonpoint Source Management Plan at http://deq.mt.gov/wqinfo/nonpoint/NonpointSourceProgram.mcpx). Another good source of information is the Clean Water Act Information Center http://deq.mt.gov/wqinfo/CWAIC/default.mcpx . These sites provide information, strategies and goals and reports that address water quality issues generally as well as water quality as it is affected by water quantity.

Water storage is an important tool for meeting future demands and responding to a changing climate. The prospect of constructing storage projects in Montana is limited by the availability of suitable locations, cost, public support, the need to mitigate environmental impacts, and limited legal and physical availability of water to store. The development of new storage projects is limited to basins where the volume of annual runoff exceeds downstream legal demands.

There are also opportunities to retain high spring flows through the use of natural systems such as riparian areas, floodplains and wetlands which act to slow runoff and promote groundwater recharge effectively storing water and releasing it slowly back to the surface water system. In this way, these natural systems fill a role similar to traditional reservoirs. Artificial recharge of alluvial aquifers may also provide additional opportunities to store water when the physical supply exceeds downstream legal demands.

The major findings and recommendations of the State Water Plan are found in the final section of this report and summarized below. All recommendations contained in the State Water Plan are subject to the existing institutional and legal framework for water use in Montana as provided by the Montana Constitution, prior appropriation doctrine, and Montana Water Use Act. Full implementation of some recommendations may require the Legislature to amend the Water Use Act.

WATER SUPPLY AND DEMAND

Water supply across Montana is controlled by the variability in seasonal temperature and precipitation. While the demand for water continues to grow, water availability varies from year-to-year and often changes dramatically within a given year. As a result, coping with supply and demand imbalances is a constant feature of water management in Montana. The importance of ensuring an adequate supply of water to meet current beneficial uses and future demands is a theme echoed by the four Basin Advisory Councils throughout the planning process.

- **Increase water use efficiency and water conservation** – As the demand for water increases, water conservation and water use efficiency to reduce the consumption of water will play a larger role in meeting the state's future needs. Looking ahead, we must focus on innovative strategies to stretch supplies and promote water conservation while protecting against the adverse effects of increased consumption.
- **Expand efforts to quantify surface water supplies and availability** – While we cannot eliminate all supply and demand imbalances, Montana can improve and expand efforts to gather the best scientific information available to quantify and forecast water supplies and availability.
- **Increase flexibility to manage available water supplies through storage and rehabilitation of existing infrastructure** – Water storage is an important part of integrated water management. Water storage creates greater flexibility in managing available supplies to meet the multiple demands of agriculture, municipalities, industry, hydropower, fisheries, recreation and water quality. While new storage projects may be difficult to site, authorize, and finance, there may be opportunities to modify the operations of existing facilities or construct smaller off-stream storage projects.

- **Explore the use of natural storage and retention to benefit water supplies and ecosystems** – Existing natural systems, such as riparian areas, floodplains and wetlands act to slow runoff and promote groundwater recharge; effectively storing water and releasing it slowly back to the surface water system. In this way, these natural systems fill a role similar to traditional reservoirs. Artificial recharge of alluvial aquifers may also provide additional opportunities to store water when the physical supply exceeds downstream legal demands. Integrating existing natural systems into Montana's water management practices will support late season flows, mitigate the impact of drought cycles, and provide environmental benefits.

- **Support and expand Montana's existing drought preparedness and planning efforts** – Drought is part of Montana's natural hydrologic regime. Drought readiness requires proactive planning and a collaborative stakeholder approach within small- to medium-sized watersheds.

WATER USE ADMINISTRATION

Historic beneficial use is the basis, measure and limit of a water right. An accurate understanding of water use is critical to Montana's ability to protect existing water rights while meeting new demands through the water right change process or new appropriations of water. Enforcement against water use without a water right or permit is also critical to the management of Montana's water resources.

- **Complete an accurate and enforceable water rights adjudication** – Adjudication of pre-1973 water rights is critical to Montana's ability to develop strategies for meeting future demands while protecting existing water rights. The water rights adjudication process must be completed as accurately as possible to establish the priority of pre-1973 water rights.
- **Enforce against illegal water use** – Montana Water users want a more efficient, less expensive, and less adversarial approach to water right enforcement. There is growing public sentiment in support of DNRC playing a more active enforcement role against illegal water use (i.e. using water without a right or permit).
- **Provide sufficient information, and legal and administrative capacity to minimize adverse impacts during times of water scarcity** – Drought planning efforts must include legal and administrative mechanisms that let water users reduce water diversions without putting their water rights at risk of abandonment and allow for the water savings to be protected.
- **Analyze additional opportunities and challenges for using water marketing, mitigation, and banking tools for meeting new demands** – Water marketing, mitigation, and water banking each offer distinct opportunities, and challenges. Understanding the potential positive and negative impacts of each is the first step toward taking advantage of these approaches.
- **Complete all outstanding tribal and federal reserved water rights compacts and work closely with federal partners to better manage federal water projects** – All four Basin Advisory Councils discussed the issue of outstanding reserved water right compacts and agreed that it is in the interest of the state, federal government, and the tribes to complete this important work. The State of Montana should work with the tribes, Montana's Congressional delegation and the federal government to complete the compacting process through congressional and tribal ratification and decree by the Water Court.

WATER INFORMATION

Water resource issues are multi-faceted and often highly localized. Understanding and resolving them requires ready access to up-to-date information. Multiple local, state and federal agencies generate and use water information in carrying out their responsibilities related to the protection or allocation of Montana's water resources. Better integration of this information will support planning, policy development and decision making at local, state and federal levels. Integration of information will also support planning and decision making by individual water users. Better access to hydrologic and climatic information at the appropriate geographic scale will result in more accurate assessments of water availability. Improved measurement and monitoring of water use will support the state's ability to determine when water is physically and legally available to meet new demands, while protecting existing water rights. Improved access to integrated water information will also support the work of water managers to distribute water by priority.

- **Support Improvements to the Montana Water Information System** – The Montana State Library's Water Information System (WIS) is the starting point for finding water resources information in Montana. The WIS makes high quality data on surface water, groundwater, water quality, riparian areas, water rights, climate data and more available to the public from one common starting place. The State Library continues to improve the WIS through the development of new data sets, interactive applications, and maps. Efforts to improve the WIS should be encouraged and supported.

- **Inventory of consumptive and non-consumptive uses** – An accurate inventory of Montana's water use, both consumptive and non-consumptive, is critical to the state's ability to meet new demands while protecting existing water users from adverse effects. Accurate information on historic water use and associated water rights will support the state's ability to determine the extent to which water is legally and physically available for new beneficial uses.
- **Monitor water supply and distribution** – Effective water management and distribution depend on accurate real-time measurements of streamflow, snowpack and soil moisture. Improving Montana's water supply and distribution monitoring network will improve the ability of water managers to adjust to seasonal supply and demand imbalances as well as plan for longer term imbalances associated with climate variability.
- **Improve and expand efforts to characterize groundwater** – Montanans are increasingly looking to the state's groundwater to meet future needs. Better groundwater information including aquifer characteristics and water monitoring data collected under the Montana Bureau of Mines and Geology Groundwater Water Assessment Program is needed statewide to identify sources of groundwater potentially available for development.
- **Improve management of surface water and groundwater as a conjunctive resource** – Montana recognizes the link between surface water and groundwater and manages them as a single resource. Additional information on interactions between groundwater and surface water from site-specific investigations and long-term monitoring as well as strategies for mitigating impacts of groundwater use on surface water users is necessary to facilitate decisions on new permitting and water right change authorizations.

ECOLOGICAL HEALTH AND THE ENVIRONMENT

Montana's natural aquatic systems, lakes and rivers and associated biological resources, support our quality of life and Montana's recreation and tourism economy. The availability of water in the appropriate quantity, quality, timing and duration is necessary to ensure the health of our water-dependent ecosystems. We must pursue proactive policies and management practices to meet the needs of aquatic ecosystems within the prior appropriation system in order to sustain the health of these valuable natural systems.

- **Provide sufficient protection for instream flows within the prior appropriation framework to maintain aquatic and riparian systems** – Coordinated efforts are needed to develop and implement strategies and tools for providing minimum instream flow regimes within the prior appropriation framework.

- **Support proactive, coordinated efforts to reduce invasive species and protect endangered species in Montana** – Both aquatic and terrestrial invasive species can negatively impact water supplies and distribution. Coordinated efforts are needed to implement actions that protect Montana's land and water resources. Experience has shown that a cooperative approach is the most effective way to address threatened and endangered species.

COLLABORATIVE WATER PLANNING AND COORDINATION

Coordination increases communication, improves efficiencies, and leverages technical and financial resources. Effective collaboration helps to inform, engage, and connect stakeholders and supports efforts to improve water management across all watersheds. It is important to coordinate efforts and involve water managers, users, and stakeholders at the watershed, basin, and statewide scale to develop sustainable management solutions.

- **Expand support for basin and community-based watershed planning** – Community-based watershed groups, conservation districts, and other organizations provide the structure and a forum to bring together stakeholders, build partnerships, and work collaboratively to develop local water management plans. It will be increasingly important to provide such groups with planning support, technical assistance, and access to information to develop, implement, and monitor water use plans as demand for water grows and the administration of Montana's water becomes more complex.
- **Encourage collaboration, coordination, and communication across local, state and federal agencies, and tribal governments** – Many local, state, federal, and tribal agencies share responsibilities for land and water management. The policies and actions of one often directly impact another. Close coordination between local, state, federal, and tribal water managers is critical for achieving outcomes that serve both economic and environmental interests.
- **Develop a plan to deliver water-related training, education, and outreach** – Water management is complicated, not only because of water's finite and variable nature, but also because of the complicated nature of the water right laws and rules used to administer it. Water education and outreach activities are necessary to provide a foundation for informed management of Montana's water resources now and in the future.

STATUTORY AUTHORITY FOR WATER PLANNING

Article IX, Section 3 of Montana's Constitution states "*All surface, underground, flood, and atmospheric waters within the boundaries of the state are the property of the state for the use of its people and are subject to appropriation for beneficial uses as provided by law*". The Constitution also states that "*The use of all water that is now or may hereafter be appropriated ….shall be held to be a public use.*

Responsibility and statutory authority for developing the State Water Plan is given to DNRC in *§85-1-203, Montana Code Annotated (MCA)*. Montana citizens are given a formal role in the planning process through basin advisory councils established in accordance with the instructions given by the legislature in *§85-1-203*(4), MCA. The role of the basin advisory councils is to make recommendations to DNRC.

STATE WATER-USER PROFILE

BETTY POTTER PROMISES TO KEEP

WRITTEN BY AL KESSELHEIM, PHOTOS BY THOMAS LEE

Water comes ribboning down the meadow, bank-full in the neat ditch. It is early morning, barely sunrise, still cool. A glittering sheet of flood irrigation spreads across the field. A pair of sandhill cranes circle in to land, their loud guttural calls filling the pale day. Curlews probe in the shallows.

Betty Potter straightens up from her work, cleaning old hay and horse manure out of the ditch where it has backed up behind a gate. Mornings are her favorite time, and May is a good month. Everything is sparkling green. The little biting gnats that get behind your ears later in the summer aren't around. The days are cool and fresh. She leans on her pitchfork, looks toward the sunrise where water from the Clearwater River pools in the low spot.

She is 72 years old, just over 5 feet tall, maybe 100 pounds after a big breakfast. She wears work overalls, a bandana on her head. Her eyes are shy, but her laugh quick and infectious. Her 4-wheeler sits near the gate while she walks the ditch, managing the flow and keeping things tidy. Her husband, Bill, died last year at the age of 96.

"I made Bill two promises," she says. "That I would never put him in a nursing home, and that I would take care of this land."

What that means is that much of her summer is spent rotating water on hay fields, keeping the ditches clear and maintained, cutting hay. She is in the fields by 6 am and would have it no other way. During the winter she logs beetle-kill timber on the property. Last winter she single-handedly logged 34,000 board feet.

"I'm not much of an inside person," she says. "I like to work."

Potter says that she puts 3,000 miles a year on her four-wheeler, between irrigating and logging. She probably walks a couple thousand, too, checking ditches.

Potter grew up in Spokane. She went to college for a semester before she came to the Blackfoot Valley, near Clearwater Junction, in 1962. "I wanted to work in Glacier National Park," she remembers, "but they were already done with hiring, so I took a two-week job here at the dude ranch cleaning cabins."

That was 50 years ago. Cabin cleaning led to cooking and other jobs. Her personality and work ethic made her a valued employee. One thing led to the next, years passed. In 1984 she married Bill, one of the partners on the ranch, and she also married this landscape.

"The only time we left the ranch was to go hiking in the Mission Mountains for a week in the fall," Potter says. "I wish we'd done more of that."

"When I came here I didn't know anything," she laughs. "I couldn't even drive a stick shift. I've learned a lot, especially after Bill got sick."

She sloshes through the wet field in rubber boots. Potter scrutinizes the banks, looking for places where horses broke down the edge or where the water release is uneven. She walks to the next gate, where she bends down to pull boards out with a hook made of rebar, and releases water lower down.

"I made Bill two promises...That I would never put him in a nursing home, **and that I would take care of this land."**

—Betty Potter

"I've fallen in a few times," she admits. "And I can't swim! Once I fell trying to cross on a board. I had to have sixteen stitches in my knee.

"I've got a bad back, a bad knee, sore shoulder. I take a lot of Ibuprofen," she shrugs and starts back toward the 4-wheeler at a brisk walk.

Potter is not a fan of center pivot irrigation. "Over my dead body," she says. "They just make a mess in the fields, and they miss too much. Flood irrigation is labor intensive, but that's exactly what I like about it."

"It takes me about two weeks to really get the acreage covered," she says. "Then I start over again. I keep irrigating until the day we cut hay." Between what she calls the Upper and Lower Rocking Chair, she manages about 3,000 acres, 250 of them irrigated.

Potter notices the little things as she works her rounds. A young bear comes down to the ditch to drink water. She carefully sets aside a caterpillar she comes across cleaning the bank. She keeps a wary eye on a steep embankment where leaky ditches have periodically washed out the road in the past.

"When we shut off the water and I find fish in the ditches," she says, "I return them to the river. Any kind of fish."

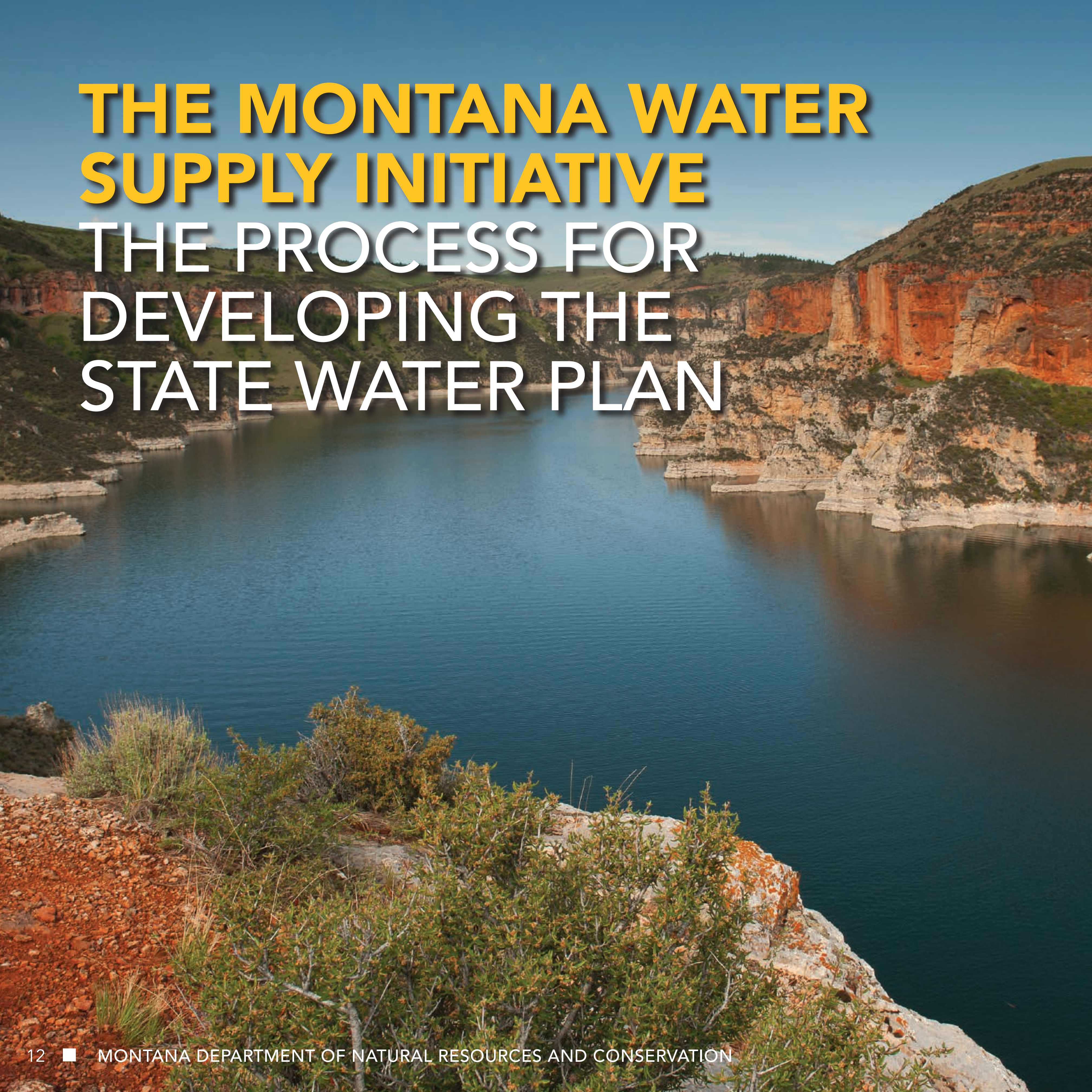
"We usually have water into mid-August," Potter says. "When the gage at Bonner gets down to 700 cfs, we have to cut back by 50% for instream flows. When it gets to 600 cfs, we have to shut things down."

"We buried Bill right here on the ranch," she says, suddenly. "On his grave it says something he used to tell me. 'When it's all said and done, we are only caretakers of the land.'"

"That's what I'm trying to do. It's not a way to get rich. It's a way of life, and I wouldn't trade that for anything." ■

THE MONTANA WATER SUPPLY INITIATIVE

THE PROCESS FOR DEVELOPING THE STATE WATER PLAN



CONVENING THE BASIN ADVISORY COUNCILS

DNRC developed the Montana Water Supply Initiative (MWSI) in order to carry out the direction provided by the 2009 Legislature to update the State Water Plan (85-1-203, MCA). The purpose of the MWSI was two-fold: first, to provide up-to-date water resource information essential for planning and estimating future water demand, and second, to actively engage citizens in developing an adaptive State Water Plan that identifies options to meet future needs, satisfy existing beneficial uses, and protect the state's water resources.

DNRC appointed a 20-member Basin Advisory Council (BAC) in each of the four major river basins in the state (Yellowstone, Lower Missouri, Upper Missouri, Clark Fork/Kootenai) for the purpose of conducting public listening sessions and to develop advisory recommendations that would serve to inform DNRC in developing the State Water Plan. Due to its large size and geographic and climatic variability, the Missouri River watershed was split for planning purposes into upper and lower basins. The Clark Fork Basin was combined with the Kootenai Basin for planning purposes due to their proximity and geographic similarity (**Figure 1**).

DNRC made a deliberate effort to secure diverse and broad representation on each of the BACs. Nominations for appointees were sought from a variety of individuals and organizations including agriculture, conservation, industry, municipal supply, and tribal interests. Nominees were chosen on the basis of expertise in their particular area of interest and the constituency they represent. DNRC contracted with professional facilitators to assist the BACs through the process of identifying issues, information exchange, and the development of specific policy recommendations.

STATE WATER PLANNING BASIN BOUNDARIES

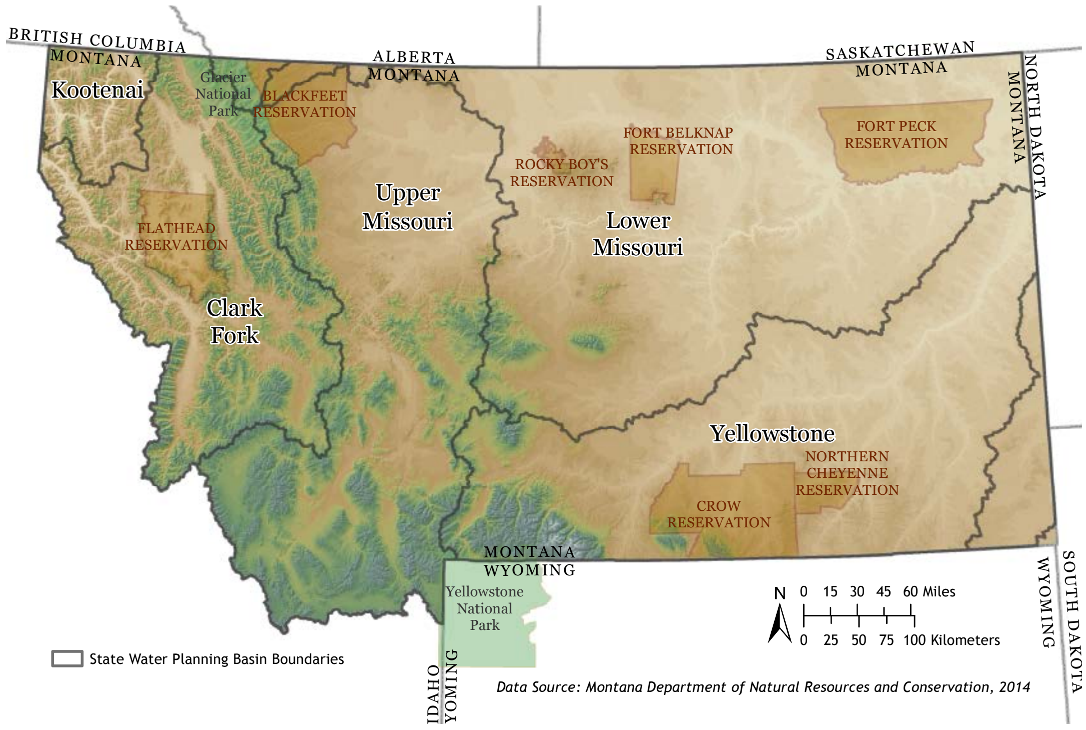


FIGURE 1: 2015 Montana Water Supply Initiative Planning Basins

THE MONTANA WATER SUPPLY INITIATIVE AND THE ROLE OF THE BASIN ADVISORY COUNCILS

The BACs were created and organized as a means of maximizing citizen input into the planning process. Previous planning efforts in the late 1980s and 1990s were driven by DNRC and associated state and federal agencies to address problems and challenges in the area of water management. In the wake of the success achieved through locally driven watershed planning efforts of the last 10 to 15 years, the BACs were intended to serve as a more direct link between the agencies charged with crafting policy and the needs and issues of stakeholders at the local and regional level. The MWSI was designed as a three-phase process culminating in the development of a recommendations report meant to inform and advise DNRC in the development of the State Water Plan.

PHASE ONE OF MWSI
ISSUE IDENTIFICATION

The implementation of Phase 1 of MWSI was a series of listening sessions used to inform each BAC on water resource issues of concern to people living in the basin. Each of the BACs held 4 to 6 public meetings in their planning basins. Meetings were designed specifically to inform the public about the state water planning process; present information on surface and groundwater supply and water management in the basin; and to provide a forum for people to voice their concerns over water issues directly to the BAC members. Twenty-three public meetings were held throughout the state attended by 521 members of the public. Public input from each of the scoping sessions was captured by each BAC in a Water Resource Issues Scoping Report. The issues identified formed the basis for the agenda of the BACs as they moved forward through the process. These reports can be found at **www.dnrc.mt.gov/mwsi**.

PHASE TWO OF MWSI *INFORMATION TRANSFER*

During Phase 2 of MWSI, technical experts made presentations on a wide range of water related topics identified in the scoping meetings and prioritized by the BACs. Experts included staff from local, state, and federal agencies, non-profit organizations, and individuals involved in water management. Presentations were diverse and ranged from highly scientific to day-to-day practical water management and decision-making. BAC members also had the opportunity to ask questions of the experts and explore topics related to the issues under consideration. This transfer of technical, scientific, and policy information provided a foundation for the BACs when they developed recommendations.

PHASE THREE OF MWSI *RECOMMENDATIONS DEVELOPMENT*

To initiate the process of developing recommendations, DNRC provided a framework to the BACs for Phase 3 that was intended to provide some consistency across the four BACs. In considering alternatives for recommendations, DNRC identified a set of criteria to screen alternatives:

- Is it technically feasible?
- Is it financially feasible?
- Is there broad public support?
- Is it actionable?
- Does the pertinent agency have the authority to implement?
- Does the pertinent agency have buy in?
- Is it in accordance with the Montana Constitution and the prior appropriations doctrine?

While it was agreed that the BACs may not have adequate information to fully apply each of the criteria, DNRC put forth the criteria so that the BACs would be aware of the limitations that might prevent adoption of a recommendation within the context of the final State Water Plan.

In early spring of 2014, each BAC facilitator prepared a Draft Basin Recommendations Report based on the work of the BACs that detailed the background, issues statements, goals, and objectives for a comprehensive set of recommendations for each basin. In April and May of 2014, each BAC held a series of meetings to take public comment on their draft recommendations. The Draft Basin Recommendations Reports were also posted on DNRC's website, and interested citizens had the opportunity to offer comments through a web survey. After a three-week public comment period, each BAC met to review and consider the public comments and adjust their recommendations. Each of the facilitators produced a Final Basin Recommendations Report that summarized the process, offered insight into the deliberations on each issue, and presented a series of advisory recommendations for DNRC to consider in developing the State Water Plan. These reports can be found at **www.dnrc.mt.gov/mwsi**.

Upon completion of Phase 3, DNRC assembled all of the information generated by each BAC during the basin planning process into individual basin plans. In addition to basin specific recommendations generated by the BACs, the basin plans include comprehensive information on water supply, consumption, future demands, and an analysis of the effects of drought and climate variability. Each basin plan serves as a standalone document for guiding the development and management of the basin's water resources and will continue to evolve to meet the planning needs of their respective basins.

The information and recommendations contained in the basin plans serve as the foundation for developing the State Water Plan. However, only the State Plan has been adopted by DNRC. In the event that guidance in one of the basin plans is at odds with the State Water Plan, the guidance offered in the State Water Plan takes precedence. Similarly, the policy recommendations offered in the basin plans represent the collective work of the individual BACs and should not be interpreted as carrying the authority of official state policy.

DEVELOPING THE STATE WATER PLAN

In contrast to the detail rich basin plans, the State Water Plan offers a broad overview of the state's water resources and lays out a path for managing those resources over the next twenty years.

The State Water Plan contains 68 recommendations for improving the management and utilization of the state's water resources over the next twenty years. The genesis for these recommendations resides in the 42 separate goals, 109 objectives, and 222 recommendations DNRC received from the four BACs. Since many of the issues addressed by each of the BACs overlapped, DNRC staff sorted and categorized the information by issue area and developed a preliminary set of draft recommendations for the State Water Plan. DNRC then organized a State Water Plan Advisory Committee comprised of DNRC staff and two representatives from each of the four BACs. This step was critical to the process of translating recommendations developed at the watershed level into recommendations with statewide applicability. This group met over two days to help craft the recommendations found in the State Water Plan.

PUBLIC PARTICIPATION AND PLAN ADOPTION

In addition to the many BAC meetings, public scoping process, and recommendations development process, DNRC also provided regular updates on the MWSI process and plan development to the Water Policy Interim Committee (WPIC) and Environmental Quality Council (EQC). DNRC presented the Draft State Water Plan to WPIC and EQC for consideration at their final interim meeting in September, 2014, and posted the Draft State Water Plan on the department's web site in advance of a public comment period that was open from September 24 through October 26. In late September and early October, DNRC held a total of 13 public hearings across the state to provide information on the planning process and to take public comment on the Draft State Water Plan. Public comments were also accepted through written correspondence, email, and through a web portal on the DNRC website. DNRC received a total of 112 written comments in addition to verbal comments received during the hearing process. Following the comment period, DNRC compiled the comments received and made final adjustments to the State Water Plan. Following plan adoption by DNRC Director John Tubbs, the State Water Plan was submitted to the 2015 Montana State Legislature.

INSTITUTIONAL AND LEGAL FRAMEWORK FOR WATER USE IN MONTANA

PRIOR APPROPRIATION DOCTRINE AND THE MONTANA WATER USE ACT

In order to legally put water to a beneficial use in Montana, a person must have a water right. The elements of a Montana water right—the right to the beneficial use of water—are dictated by the prior appropriation doctrine. In its simplest form, the prior appropriation doctrine provides that a person's right to use a specific quantity of water depends upon when that use began—first in time, is first in right. A water right consists of a priority date, a purpose of use, point of diversion, a source, place of use, period of use, and a quantity reflected in a flow rate, volume or both. There is no hierarchy among beneficial uses other than priority date. A water right does not create ownership in the water itself. Rather, it creates a property interest in the right to beneficially use a quantity of water for a specific purpose. Accordingly, actual historical beneficial use constitutes the basis, measure, and limit of a water right.

Prior to July 1, 1973, Montana's prior appropriation system provided two primary methods for acquiring a water right: 1) a water user could simply construct a diversion and put the water to beneficial use (known as a use right); or 2) a water user could comply with the statutory notice of appropriation requirements (known as a statutory right). No prior authorization was required and the state had no control over use of this state-owned natural resource. As demands and conflicts over water increased, it became increasingly difficult to administer water rights because the rights were not recorded in a central location.

The 1972 Montana Constitutional Convention sought to remedy Montana's antiquated system while at the same time preserving the fundamental prior appropriation principles of first in time, first in right and beneficial use as the basis, measure and limit of a water right. To accomplish this goal the Article IX Section 3(1) of the Montana Constitution recognized and confirmed "existing rights" to the "use of any waters for useful or beneficial purpose." The Constitution also confirmed, in Article IX Section 3(3), that all waters within Montana are the property of the state for the use of its people and are subject to appropriation for beneficial uses as provided by law. Finally, in order to provide the necessary tools to better manage use of Montana's water resources, Article IX Section 3(4) of the Constitution charged the legislature with providing for the administration, control, and regulation of water rights and establishing a system of centralized records.

The Legislature responded to these constitutional charges by passing the Montana Water Use Act (Act), effective July 1, 1973. In order to fulfill the constitutional mandates of Article IX, the Act established an adjudication system to adjudicate pre-July 1, 1973 water rights, a permit system to control and regulate post-July 1, 1973 water appropriations, changes in use of existing water rights, and a centralized system of recording water rights.

The Act confirmed the fundamental principles of Montana's prior appropriation doctrine, including the following:

1. Montana's water belongs to the state for the beneficial use of its people. Therefore, water right holders do not own the water; they possess the right to use the water.
2. Doctrine of Prior Appropriation (first in time, first in right).
3. "Use it or lose it." A water right holder must use the water or risk losing the right to it.
4. The water diverted must be for a beneficial use, and all beneficial uses are equal under the law.

5. A water right is a property right and can be separated from the land.
6. One must have a water right to beneficially use water, and after July 1, 1973, new water rights can be obtained only from the DNRC, generally through the permitting process.
7. Any change in the purpose, place of use, place of storage, or point of diversion of a water right can not adversely affect other water rights and must first be approved by the DNRC.

Over time, the Act has refined elements of the permitting and change process to reflect increased understanding of water use and resources in the state. The Act has also evolved to provide for state-based water reservations, temporary changes and leases for instream flows, and permits and change authorizations for marketing and mitigation. However, these refinements continue to be subject to the fundamental principles of the prior appropriation doctrine.

The Act authorized the DNRC, the Montana Water Court and the district courts to fulfill different roles in execution of the charges of both the Act and the Montana Constitution.

Montana Department of Natural Resources and Conservation

- Administers the portions of the Act that relate to water uses after June 30, 1973 such as Permits and Change Authorizations;
- Provides training for court appointed water commissioners;
- Provides technical information and assistance to the Water Court on water rights claims (pre-July 1, 1973) including examining those claims;
- Maintains a central water rights record system;
- Investigates complaints of illegal water use; and
- Other duties related to Water Operations, Water Management, and State Water Projects.

Montana Water Court

- Adjudicates water rights as they were protected under the laws pre- July 1, 1973;
- Decides any legal issues referred from the District Court on pre- July 1, 1973 water rights; and
- Assists District Courts with enforcement.

District Courts

- Can issue injunctive relief while it certifies water rights issues to the Water Court;
- Appoints Water Commissioners for enforcement; and
- Manages the enforcement of water rights and handles complaints by dissatisfied water users.

Water Rights Compact Commission (Commission)

- Negotiates settlements with federal agencies and Indian tribes claiming federal reserved water rights within the State of Montana; and
- Negotiates on behalf of the Governor's Office and represents the interests of the State water users.

Attorney General

- The Water Court may join the Attorney General to intervene, on behalf of the state, in the adjudication of water right claims that are being decreed by the Water Court.

Legislature

Provides policy direction and laws for the administration of waters. When the Legislature is not in Session, two interim committees have oversight of water related issues:

- *Water Policy Interim Committee (WPIC)* – permanent, joint bipartisan committee that studies water issues in order to develop a clear policy direction and necessary legislation to guide Montana's water policy.
- *Environmental Quality Council* – contributes policy oversight to the administration of state water rights by advising and updating the legislature and overseeing institutions dealing with water, and communicates with the public on matters of water policy.

WATER RIGHTS ADJUDICATION AND THE WATER COURT

The Act set forth the framework for Montana to embark upon a state-wide general stream adjudication of pre-July 1, 1973, existing water rights. The adjudication serves to recognize and confirm existing water rights as required by the Constitution. The adjudication involves examining, litigating and decreeing claims to water with priority dates prior to July 1, 1973 through the Water Court (§85-2-2 MCA).

The first phase of the adjudication process involved the examination of each water right claim for factual and legal issues in accordance with Montana Supreme Court Claim Examination Rules. Over 220,000 claims for pre-1973 water use were received. This phase of examination was performed by the DNRC and completed in 2014. Additionally, the Water Court issued an order for DNRC to re-examine certain elements of claims in 45 basins that were not examined according to the current and more rigorous Montana Supreme Court Claim Examination Rules. The second phase of the adjudication involves issuance of temporary and/or preliminary decree, public notice, litigation of objections, and resolution of issue remarks (Figure 2). Following the resolution of objections and issue remarks, the Water Court will issue final decrees for each of Montana's 85 river basins which will define pre-July 1, 1973 water rights by owner, purpose, priority date, source, place of use and other elements of the water right. The current target date for the Water Court to issue final decrees is 2028.

Montana's water rights adjudication process will not be complete until all Federal and Tribal reserved water right compacts have been decreed by the Water Court. Prior to review by the Water Court, all compacts must be ratified by the Montana Legislature, approved by appropriate federal authorities, and in the case of Tribal compacts approved by Tribes. Where federal authorization or federal appropriations are needed to implement provisions of the settlement, congressional approval is required.

To date, seventeen compacts have been negotiated and approved by the Montana Legislature. A negotiated compact with the Confederated Salish and Kootenai Tribes (CSKT) is awaiting approval by the Montana Legislature. If the legislature does not approve the proposed CSKT compact, the Tribes must file their claims with the Water Court prior to July 1, 2015.

STATEWIDE ADJUDICATION DECREE STATUS

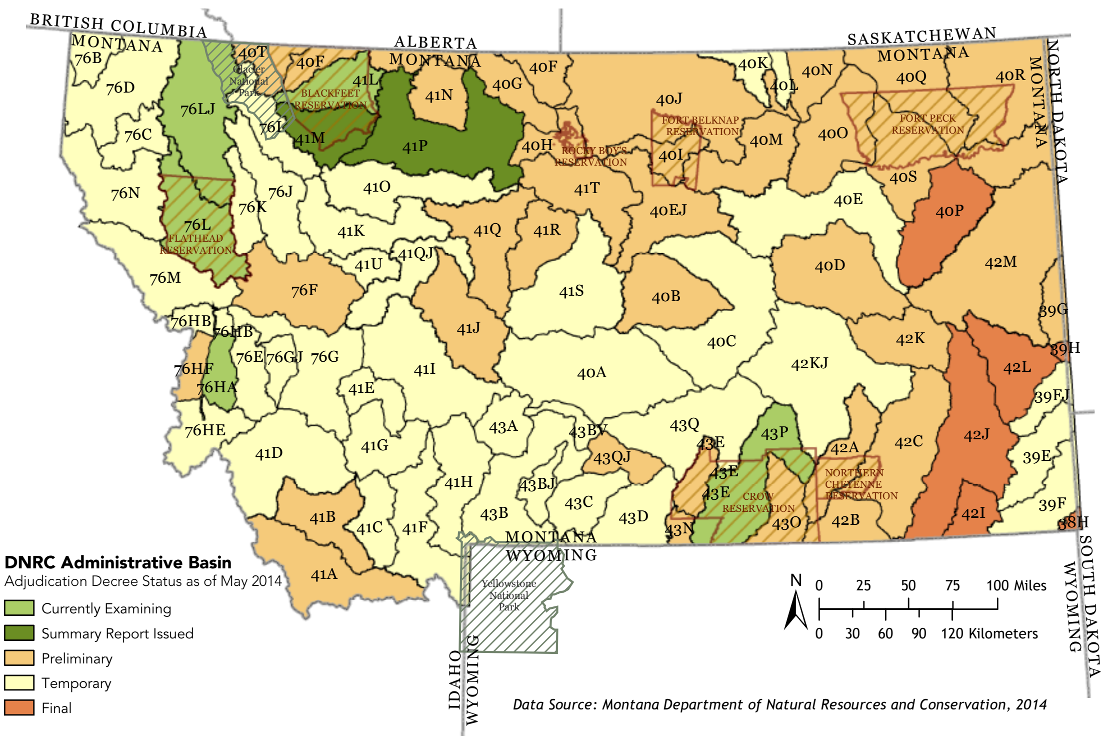


Figure 2: *State-wide General Stream Adjudication of pre-July 1, 1973 Water Rights as of August 2014*

FEDERAL AND TRIBAL RESERVED WATER RIGHT COMPACTS

In Montana, federal reserved water rights have been claimed for seven Indian reservations, for allotments for the Turtle Mountain Chippewa Tribe, and for federal lands within the State (national parks, forests, national wildlife refuges, and federally designated wild and scenic rivers).

The doctrine of reserved water rights evolved to ensure that Indian reservations and public lands set aside by the federal government would have sufficient water to fulfill the purposes for which they were established. Whereas most western water rights (state-based appropriative rights) have a priority date based on when water was first put to beneficial use, federal reserved water rights have a priority date that goes back at least as far as the date on which the lands were set aside.

The reserved water rights doctrine is rooted in a number of judicial decisions, beginning with a 1908 U.S. Supreme Court decision now known as the Winters Doctrine. The case of *Winters vs United States* involved a dispute between Native Americans of the Fort Belknap Reservation and homesteaders over the use of the Milk River. Water use of the settlers upstream from the reservation diminished water supplies for agriculture on the reservation. The dispute eventually made it to the U.S. Supreme Court.

The Winters decision held that when Congress created the Fort Belknap Reservation, sufficient water necessary to support the purposes of the reservation was implicitly set aside. Therefore, although the homesteaders had perfected their water rights under Montana state law, the water right of the Indians of the Fort Belknap Reservation was prior, or senior in use.

The rationale used in the Winters decision on behalf of Native Americans also applies to public lands held by the federal government for national parks, wildlife refuges, national forests, military bases, wilderness areas, or other public purposes. It holds that when Congress authorized the establishment of federal land, it implicitly intended to reserve enough water to fulfill congressional purposes. This idea of "implied rights" serves as the basis and foundation for tribal and federal claims to state waters embodied in the many compacts negotiated by the state of Montana and its many tribal and federal partners.

Montana's Reserved Water Rights Compact Commission (RWRCC) was established by the Montana Legislature in 1979 as part of the state-wide general stream adjudication process for the purpose of negotiating and quantifying federal and tribal reserved water rights. It is important to note that Montana is one of a handful of states that has relied upon the use of negotiated settlements instead of the courts to resolve claims for federal and tribal water rights throughout the state. Please see the appropriate Basin Watershed Plans for a more complete discussion of the specific federal and tribal compacts that have been negotiated throughout Montana.

NEW BENEFICIAL WATER USE PERMITS, CHANGE IN USE AUTHORIZATIONS, AND THE DNRC

Under the Act, the DNRC has jurisdiction over all changes in use and new appropriations occurring after July 1, 1973. The DNRC has the authority to enforce against illegal water use, and performs a number of other responsibilities related to post July 1, 1973 water use, planning and management in Montana.

In exercising its jurisdiction over new appropriations, the DNRC evaluates the proposed use pursuant to the §85-2-311, MCA, permit criteria. These criteria require the applicant prove that water for a proposed appropriation is both physically and legally available, that existing appropriators will not be adversely affected, that the proposed use is a recognized beneficial use of water, that the proposed diversion is adequate, and that the applicant has a possessory interest in the place of use.

Similarly, DNRC exercises its jurisdiction over changes in use for existing water rights pursuant to the Act's change criteria found at §85-2-402, MCA. A water user can change the place of use, purpose of use, point of diversion, and place of storage for a water right. While these elements of a water right are subject to being changed, a water user may not expand the extent of the underlying water right. Therefore, evaluation of the change criteria focuses on the historic beneficial use of the underlying water right, alteration of return flows, and a determination of whether the change in use will adversely affect other water users (senior and junior) on the source. The change provisions of the Act are discussed in more detail starting on page 57 of this plan.

The permit and change provisions of the Act reflect a fundamental shift from pre-July 1, 1973, water appropriation in that they require prior approval from the DNRC before water is appropriated or a change in use occurs. The Act provides the DNRC with the authority to condition, revoke, or modify permits and change authorizations as necessary to ensure compliance with the Act through administrative proceedings. §85-2-311, 312, and 314, MCA.

Over the past 40 years, DNRC has developed and refined the permit and change procedures in an effort to maintain the balance between authorizing new water uses and changes while at the same time protecting existing water rights from adverse effects. The DNRC has developed specialized expertise and adopted rules on various aspects of water availability and water use throughout the state. See Title 36, Chapter 12, Admin. Rules Mont. For example, DNRC's rules include information regarding accepted methods for measuring water availability in gaged and un-gaged sources, estimating historic consumptive use, and modeling groundwater aquifer characteristics and properties.

WATER RESOURCE PROJECT AND PROGRAMS FUNDING

Most water resource improvement projects in Montana are a collaboration that starts at the local level. Funding is often leveraged from a variety of sources to support a single project. Montana offers numerous grant programs aimed at conserving, protecting, and expanding the beneficial use of Montana's water.

Grant Programs available through the Department of Natural Resources and Conservation include:

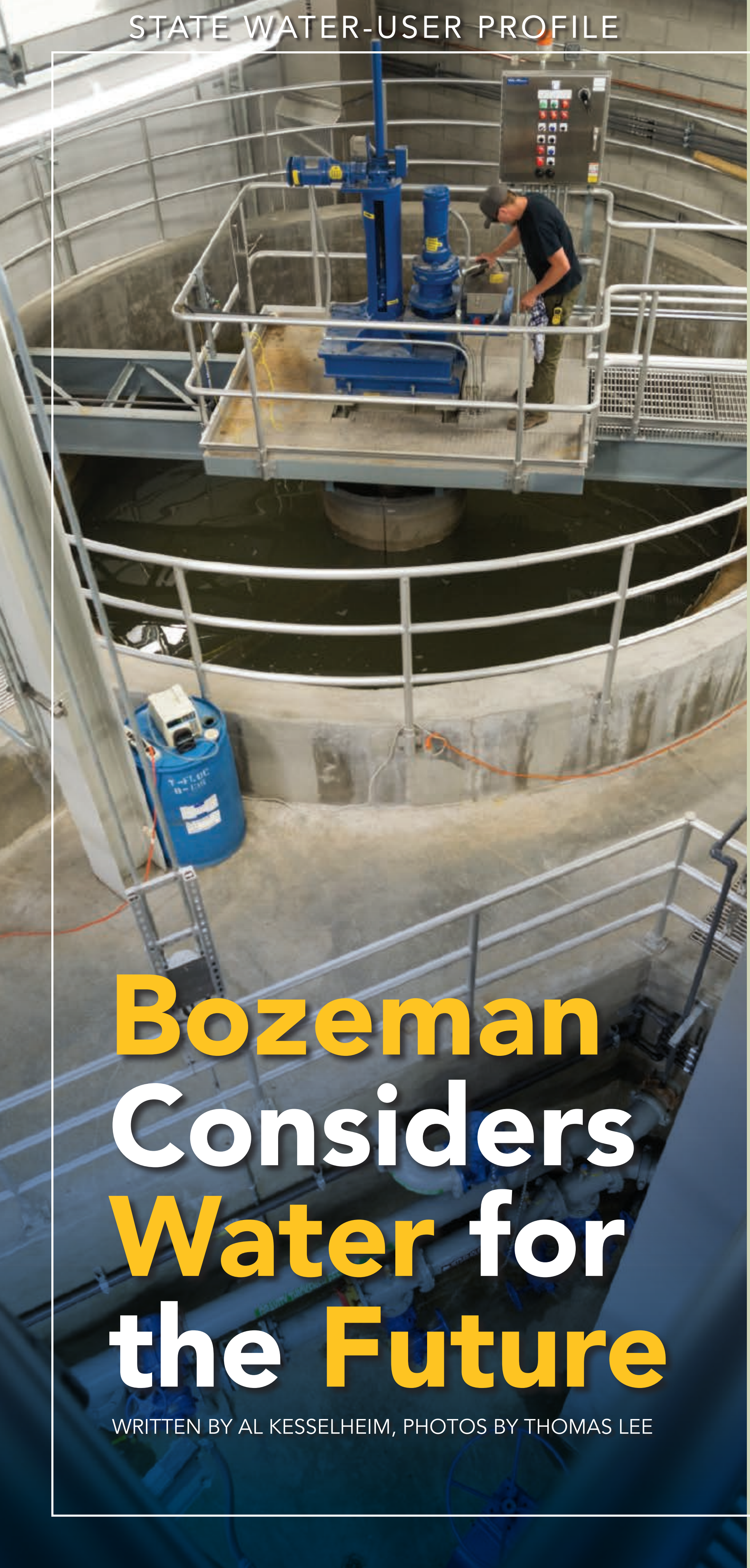
1. **Renewable Resource Project Grants** fund projects that conserve, develop, preserve or improve management of Montana's renewable resources such as water. Grants are available up to $125,000.
2. **Renewable Resource Planning Grants** support planning activities for projects that are eligible for Renewable Resource project grants (above). Grants are available up to $15,000.
3. **Reclamation and Development Project Grants** fund activities that reclaim natural resources damaged by mineral extraction, hazardous waste or activities that meet a crucial state need. Grant limit is $500,000.
4. **Reclamation and Development Planning Grants** provide up to $50,000 to support planning for natural resource projects eligible for Reclamation and Development Project Grants (above).
5. **Reclamation and Development Aquatic Invasive Species Grants** fund projects that protect natural resources from aquatic invasive species. Grants are available up to $25,000.
6. **Irrigation Development Grants** fund projects leading to development of new irrigation or increased value of agriculture. Grants are available up to $20,000.
7. **Private Water Grants** are available to individuals or non-governmental groups for up to $5,000 or 25% of project costs whichever is less. These grants fund projects that benefit water resources.
8. **Emergency Grants** fund activities needing immediate attention to prevent substantial damage or legal liability. Must benefit or develop renewable resources such as water.
9. **Conservation District Grants (House Bill 223 Grants)** provide up to $20,000 for projects sponsored by a Montana Conservation District under its authority.
10. **Conservation District Development Grants** are intended to increase a conservation district's ability to meet statutory requirements of developing and implementing locally led conservation projects. Grants are available up to $10,000.
11. **Education Mini-Grants** provide up to $500 for youth or adult educational programs that address natural resource conservation. Eligible projects must be approved by a Montana Conservation District.

Grant Programs available through the Department of Fish Wildlife and Parks include:

12. **Future Fisheries Improvement Program** has provided an average of $800,000 annually since its inception in 1995 to restore essential habitats for the growth and propagation of wild fish populations in Montana's lakes, rivers and streams. Contact the Montana Dept of Fish Wildlife and Parks for additional information http://fwp.mt.gov

Grant Programs available through the Department of Environmental Quality include:

13. **The Montana Department of Environmental Quality's (DEQ) 319 Grant Program** provides funds to restore water quality in water bodies whose beneficial uses are impaired by nonpoint source (NPS) pollution and whose water quality does not meet state standards. DEQ strongly encourages the development and implementation of science-based, locally-supported Watershed Restoration Plans (WRPs) to guide these efforts.



Bozeman Considers Water for the Future

WRITTEN BY AL KESSELHEIM, PHOTOS BY THOMAS LEE

"50 years ago, 100 years ago, people sat down and thought about Bozeman's water," says Craig Woolard, Bozeman's Director of Public Works. "We're dealing with those decisions today—their foresight, and also their mistakes. A big part of our work day is spent fixing problems started 50 years ago, and trying not to make those kinds of mistakes today."

"Part of the reason I took this job is that Bozeman is really trying to look ahead and take comprehensive stock of the future," Woolard continues. "It speaks to a quality of stewardship that doesn't happen everywhere."

"As recently as 5 or 6 years ago, Bozeman was on the 'dam train'," says Carson Taylor, Bozeman City Commissioner. "That was the go-to option everyone assumed would be the next thing on the horizon when water shortages became an issue."

Building a dam is one of those satisfying fixes, a tangible, targeted plan that everyone can understand and that sounds plausible. Also, something that can be put off to some murky future date when whoever is in charge then can deal with the particulars.

"Around 2010 we decided to take a hard look at those assumptions," says Taylor. "We started asking the difficult questions about the status of realistic water rights, about the cost/return ratio of building a dam. Did it really pencil out? Turns out that there were some problems with the assumptions everyone was making.

"When you depend on engineers for your plans, you get schemes that reflect a love affair with technology," stresses Taylor. "There were even plans for piping water from reservoirs on the Missouri. Of course engineering has to be part of the process, but these plans often don't factor in bigger picture costs, things like the impacts on the environment."

While some sort of dam or system of reservoirs in the foothills south of Bozeman may still be in Bozeman's future, the issues raised in the early assessment provoked the City Commission to take on a full-scale study of options.

"We're a headwaters community," stresses Woolard. "We don't have the main stem of the Missouri River flowing past to count on. What that means is that we have to look at an all-of-the-above approach to water supply."

Starting in 2010, Bozeman's City Commission took steps to get a handle on the big picture. They hired a consulting firm and established a Technical Advisory Committee with a diversity of stakeholders, from Trout Unlimited to agriculture. It wasn't rocket science, but it cost money and took genuine effort. Mostly, it took a willingness to look at realistic components of a potential solution to future water issues, and to do it sooner than later.

By definition, these studies are part crapshoot. Population estimates are at best informed guesswork. Planners used a projected population of 120,000 for 2060 and came up with a municipal water demand of 17,000 acre-feet per year. Currently, the city can adequately manage 10-12,000 acre-feet. The million-dollar question was, how does Bozeman cover that shortfall?

What emerged from several years of study, a clear-eyed look at options, and hundreds of hours of volunteer effort is the Integrated Water Resources Plan, which essentially codifies the all-of-the-above approach to Bozeman's water for the next half century.

The first step in the plan is to emphasize conservation. Bozeman hired a conservation coordinator, Lain Leoniak, who is one of the first paid conservation specialists in Montana city government.

"This is something we can start right now," says Woolard. "It begins with education, everything from more efficient toilets to community outreach and billing. It's the common sense approach."

It's also tricky, because it requires challenging long-held attitudes and practices. "It's a level of consciousness," emphasizes Taylor. "It means that you think about water use with every decision, every project."

Part of conservation for Bozeman, as with many municipalities, is keeping up with maintenance. "We want to drop leakage in our pipes and infrastructure from 20 percent to 10 percent," says Taylor. "That's thousands of acre feet right there."

"We've been investing in leak detection and a program of repairs. We want to be 'Best In Class' when it comes to infrastructure efficiency," agrees Woolard.

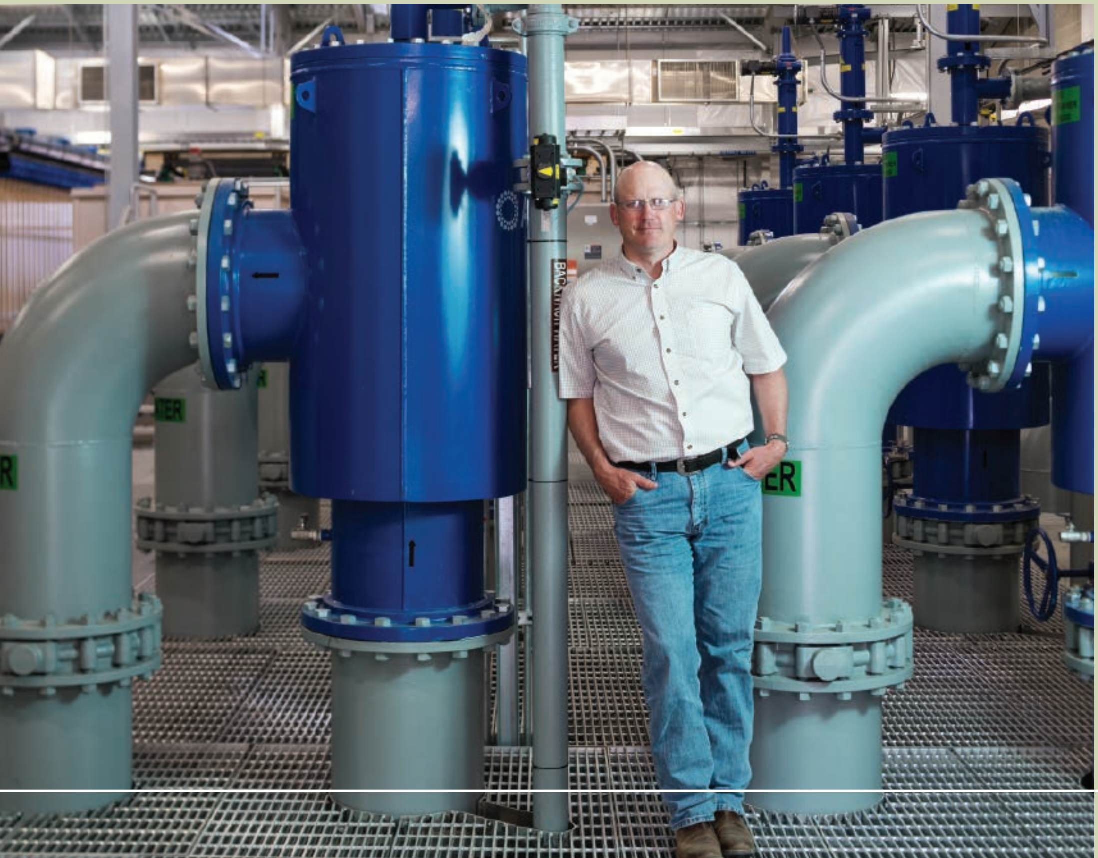
Bozeman also built a state-of-the-art water treatment plant in Sourdough Creek that Woolard calls "the nicest treatment facility in the state."

At the same time, Bozeman is looking long-term at upgrading the supply from Lyman Creek, which is Bozeman's oldest source of city water, while also exploring potential sources of groundwater supply and the potential for a set of small reservoirs in the Sourdough drainage which could be instrumental in maintaining a steady and predictable supply.

"It never stops," stresses Woolard. "You have to keep on top of it constantly. It isn't something that ever gets done."

"Just because we have this document doesn't mean we can sit back," agrees Taylor. "We'll revisit the plan every five years or so."

In every scenario, there are the weaknesses that give planners nightmares.



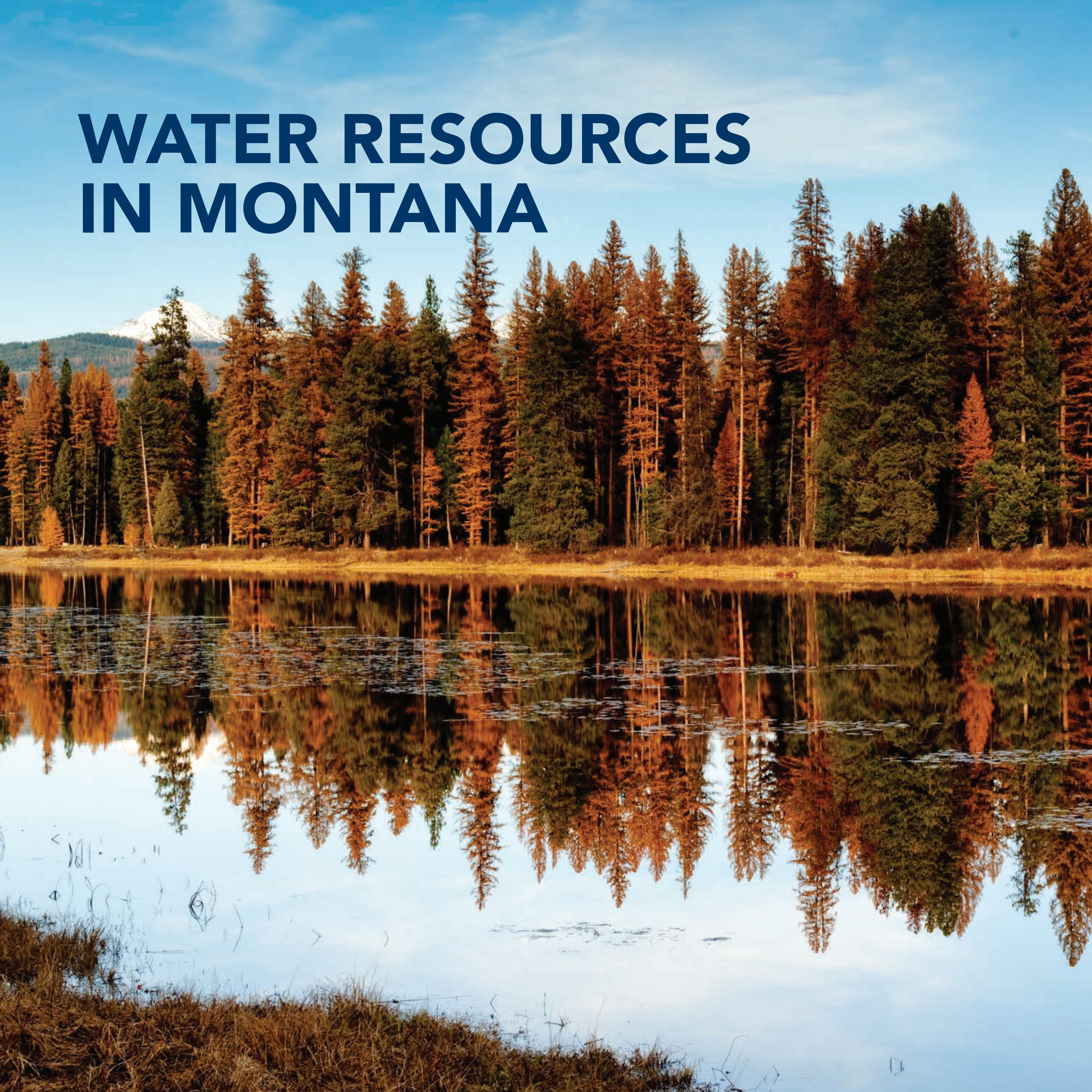
"What keeps me up at night," admits Woolard, "is our lack of redundancy in treated water storage. At this point we have about a 10-million-gallon capacity. That's one day of peak summer demand. It's the riskiest aspect of Bozeman's system."

The good news, despite an occasional sleepless night, is that there is a plan and a commitment to work within its principles. ■

"We've been investing in leak detection and a program of repairs. We want to be 'Best In Class' when it comes to infrastructure efficiency."

—Craig Woolard

WATER RESOURCES IN MONTANA



SURFACE WATER RESOURCES

The following information about Montana's surface water resources is summarized from more detailed information provided in the individual basin reports.

Straddling the Continental Divide, Montana is headwaters to several major river systems of the northern Rockies, with both sides of the divide spawning rivers of national importance (Figure 3). About 25,000 square miles of Montana's land area, or 17 percent, lies west of the divide. The other 122,000 square miles, or 83 percent, lie on the east side. Although the Clark Fork and Kootenai River Basins west of the divide drain a smaller area, they produce substantially more water than the Missouri and Yellowstone Basins east of the divide. The headwaters of the Clark Fork and Missouri Rivers originate in Montana, whereas the Kootenai and Yellowstone headwaters are in British Columbia and Wyoming respectively.

STATEWIDE AVERAGE ANNUAL FLOW ACCUMULATION

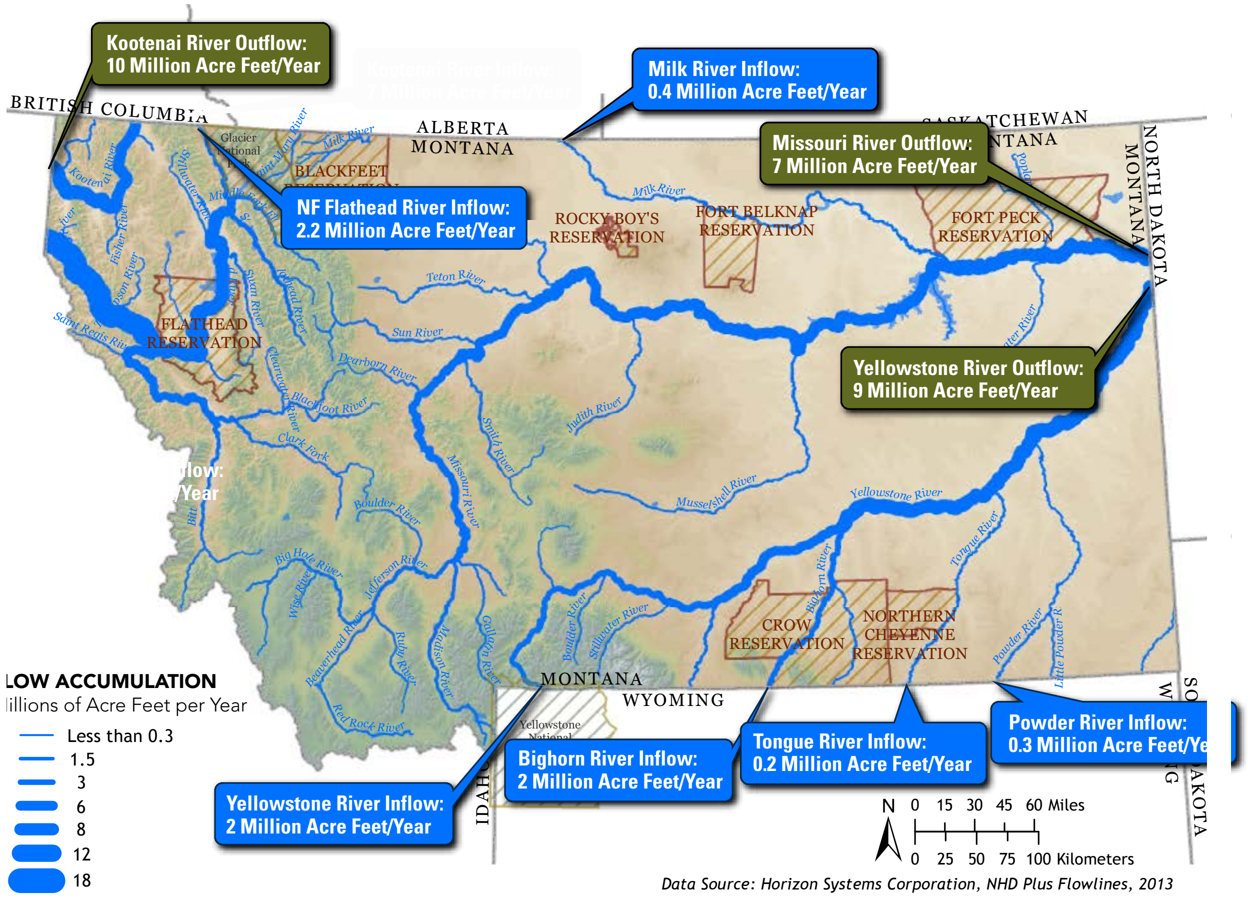


Figure 3: Statewide average inflows and outflows in Montana

Climate

West of the divide, the Clark Fork and Kootenai Basins have a Pacific Northwest climate, which is generally wetter and more temperate than the rest of the state (Figure 4). Higher elevations receive a heavy winter snowpack, and much of the basin receives more rainfall than lands to the east. As a result, total water yield and water yield relative to basin area are far greater in the Clark Fork and Kootenai basins than in other parts of Montana. Even so, some valley bottomlands receive less than one foot of moisture annually, similar to much of the eastern Montana prairie. Most communities and agricultural activities are located in drier valleys.

East of the Continental Divide, Montana is generally drier, windier, and experiences more extreme seasonal temperature fluctuations. Summers are hot and dry, and winters cold. Valley and prairie lands are arid to semi-arid, some receiving less than 10 inches of moisture a year. High elevations east of the divide accumulate a heavy snowpack and also receive more rainfall than the lower elevations.

Opportunities for Research and Investment

The mission of the Water Resources Division of DNRC is to promote and coordinate the beneficial use, conservation, protection and development of Montana's water resources. Implementing this mission is complicated by the fact that water is in high demand across the state, yet its abundance varies widely in time (weeks, months, and seasons) and space (geographic location). The primary source of surface water data that DNRC uses to monitor the state's water resources is gathered from a network of stream gages operated by the State of Montana and the U.S. Geological Survey (USGS), in addition to SNOTEL (SNOw TELemetry), gages operated by Natural Resource Conservation Service (NRCS).

The USGS currently operates over 200 stream gages that measure real-time stream stage and streamflow on Montana's mainstem rivers and many of their larger tributaries. DNRC currently provides funds to operate and maintain forty-four of these gages through the USGS Cooperative Water Program. Each of the USGS gages provides critical information to support the management of the state's water resources.

NRCS currently operates 90 SNOTEL sites in Montana. These sites are generally located in high-mountain watersheds where access is often difficult or restricted. Each site measures snow water content, accumulated precipitation, and air temperature. Some sites also measure snow depth, soil moisture and temperature, wind speed, solar radiation, humidity, and atmospheric pressure. These data are used to forecast yearly water supplies, predict floods, and for general climate research.

Data provided by both the USGS stream gage program and NRCS SNOTEL program are critical to Montana's ability to monitor and manage its water resources. Continued funding for both of these programs should be encouraged at the state and federal levels.

STATEWIDE MEAN ANNUAL PRECIPITATION

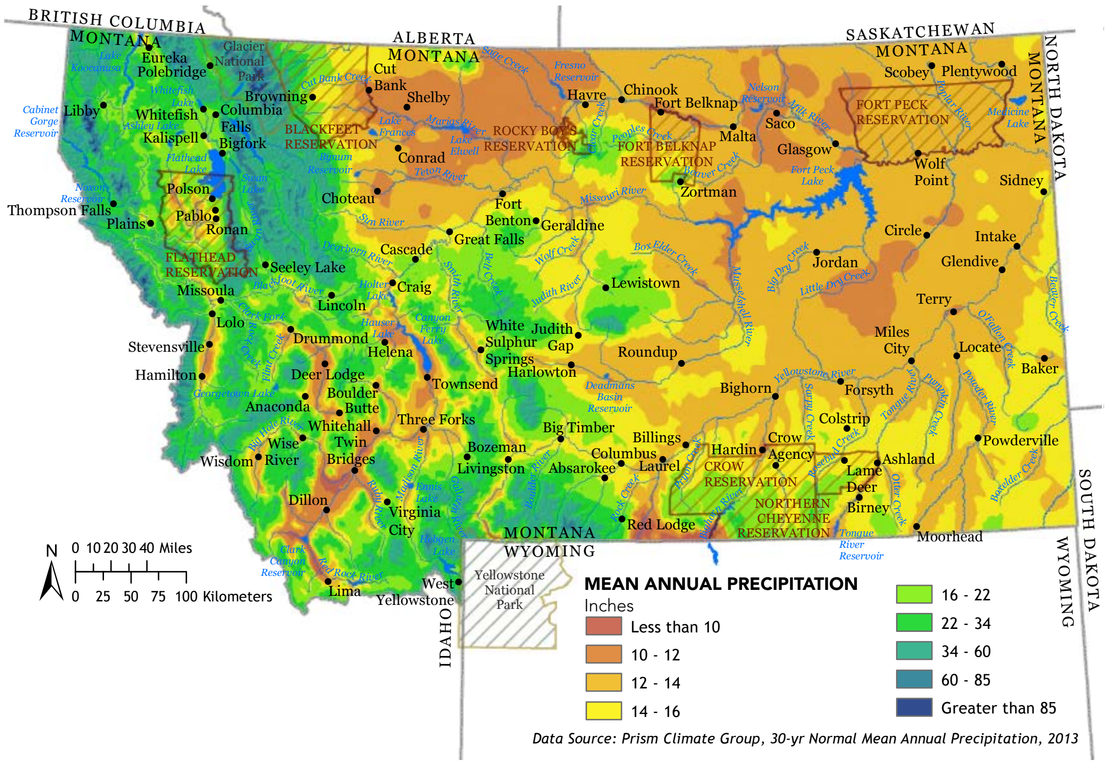


Figure 4: *Mean annual precipitation in Montana*

Montana's ability to monitor and manage its water resources will be significantly enhanced by investing in the development of a state-based stream flow monitoring network focused on collecting real-time hydrologic information on Montana's smaller streams and tributaries. Hydrologic information generated through this network will enhance decision making and policy development related to administering the Montana Water Use Act, including new appropriations, change applications, decree enforcement, and implementation of federal water right compacts. Gages installed to monitor stream flows and reservoir levels at state water projects will enhance reservoir management and operation. Information generated by the network will also support the objectives of court appointed water commissioners, senior water right holders, local watershed groups (drought management planning), MT Bureau of Mines & Geology (groundwater studies) Dept of Fish Wildlife and Parks (instream flow), and the Dept of Environmental Quality (flow related water quality monitoring).

The robust collection of both stream flow and snowpack data will assist DNRC with planning for the long-term sustainability of the state's water resources. Information on real-time streamflows will aid DNRC in developing basin water budgets, evaluating water supplies on multiple scales, and evaluating proposals to increase storage. Additional hydrologic data will also support the development of river system planning models to simulate potential impacts related to increased development, climate change, and downstream demands.

GROUNDWATER RESOURCES

The following information on Montana's groundwater resources is summarized from the more detailed information provided in the individual basin reports.

Aquifers are an important water source, but whether groundwater is physically available at any given location depends on the on-site physical characteristics of the aquifer, recharge to the aquifer from precipitation, and interactions with surface water. The most common sources of groundwater in Montana are shallow sand and gravel aquifers (surficial aquifers) along the floodplains of major streams and rivers (Figure 5). These alluvial aquifers are by far the most common sources of water for irrigation, municipal, industrial, household, and livestock purposes.

Bedrock aquifers are another important source of groundwater in Montana (Figure 6). Bedrock aquifers in western Montana are limited to the edges of valleys where fractures and faults are sufficient to provide adequate water supplies for individual residential or small public water supplies that rely upon multiple wells to provide an adequate water source. Bedrock aquifers in sandstone and limestone rock formations are an important source of groundwater in the central and eastern parts of the state providing water supplies for domestic and stock uses, and occasionally for larger municipal or industrial uses. The available quantities and water quality of sandstone aquifers, however, generally preclude their use for irrigation.

STATEWIDE SURFICIAL AQUIFERS

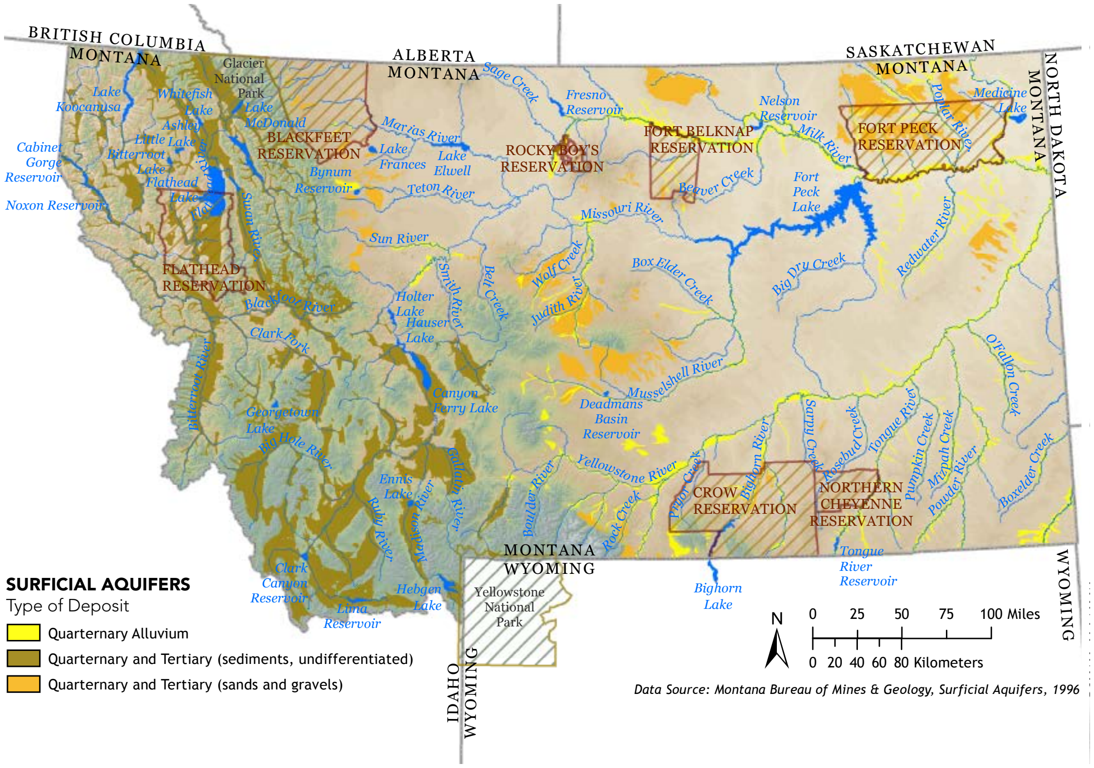


Figure 5: *Surficial aquifers in Montana*

STATEWIDE BEDROCK AQUIFERS

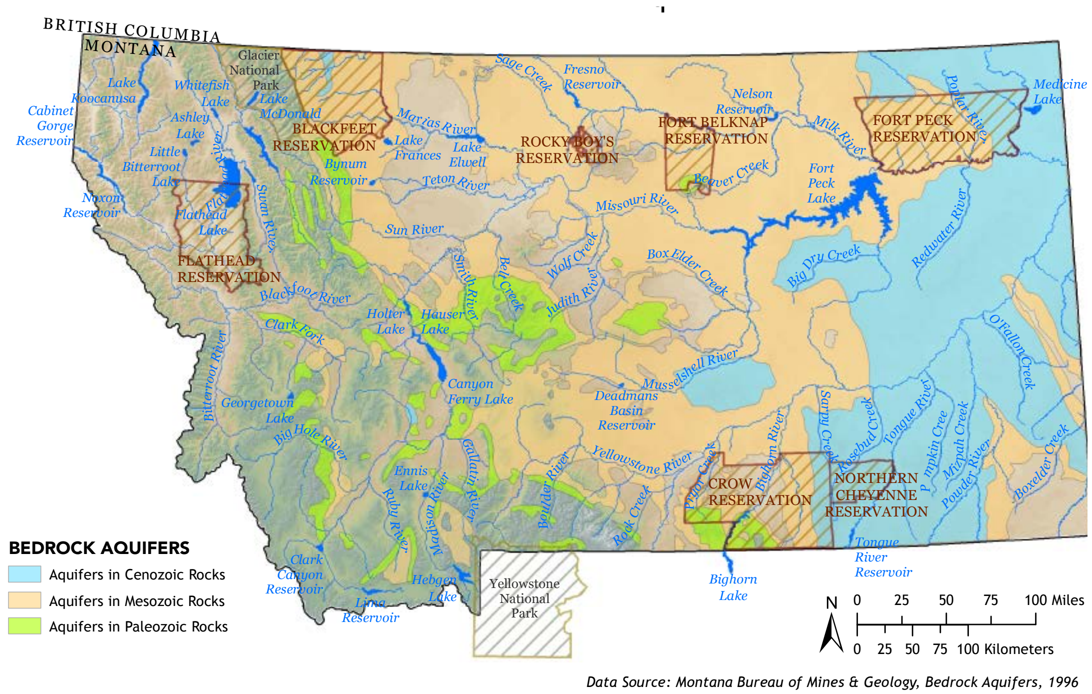


Figure 6: *Bedrock aquifers in Montana*

All aquifers, particularly alluvial aquifers, store considerable quantities of water that can be accessed by wells for water supplies and that also contribute to surface water. The year-round contribution of groundwater to streamflows (Figure 7) is known as base flow and is important for sustaining flow in streams outside the spring months. Much of the groundwater that contributes to surface water circulates at shallow depths in mountainous regions and may not come from productive aquifers or be readily accessible for use. Withdrawal of groundwater stored in an aquifer may deplete surface water flows and decrease the amount of water available for surface water users and instream flows.

Opportunities for Research and Investment

In basins closed to new surface water appropriations, groundwater may be the only source available for new appropriations. However, surface water and groundwater are a single resource that cannot be administered separately. Information on interactions between groundwater and surface water from site-specific investigations and long-term monitoring, and strategies for mitigating impacts of groundwater use on surface water users is necessary to facilitate new appropriations.

The Montana Bureau of Mines and Geology and the U.S. Geological Survey collect data and conduct studies of groundwater resources and interactions with surface water. These studies are critical to the support of decisions by water users as well as county governments and DNRC. Groundwater studies provide the data and/or modeling tools necessary to evaluate the impacts of new groundwater uses on water levels in other wells and surface water flows. Collection of groundwater data and additional studies need to be prioritized to ensure adequate information on aquifer properties and groundwater connection to surface water are available to support informed decisions and policy development.

STATEWIDE BASEFLOW INDEX BY 8 DIGIT HYDROLOGIC UNIT

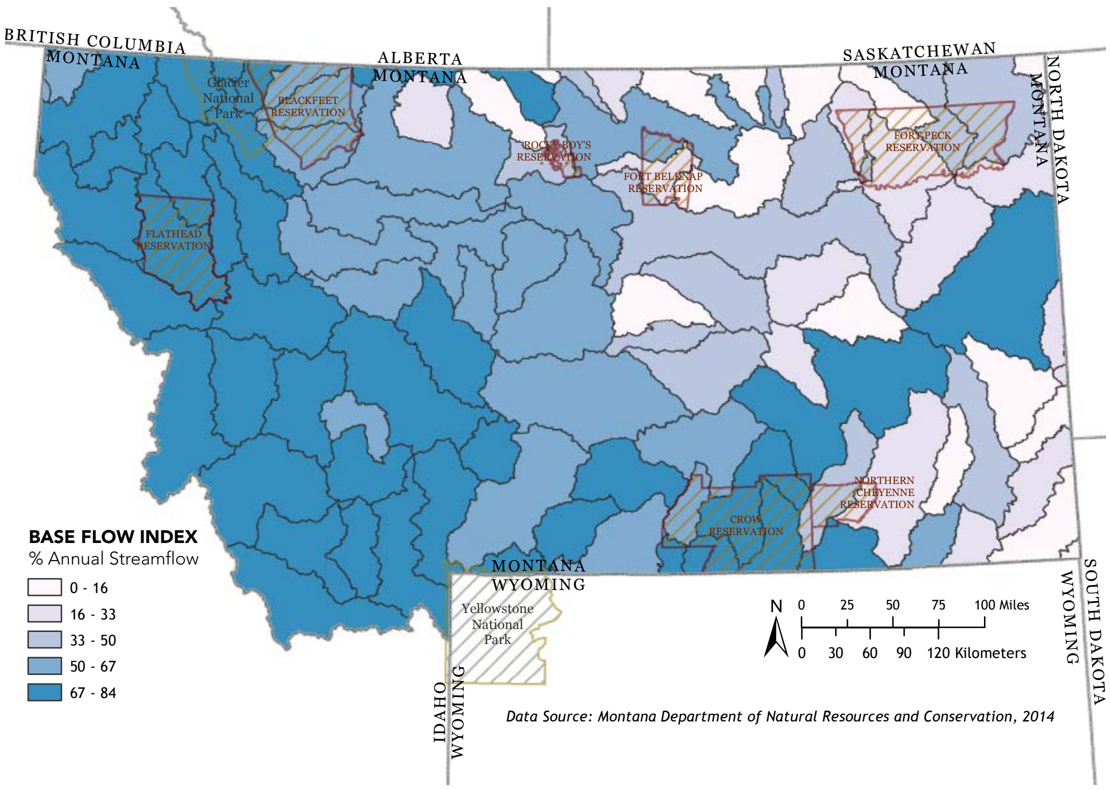
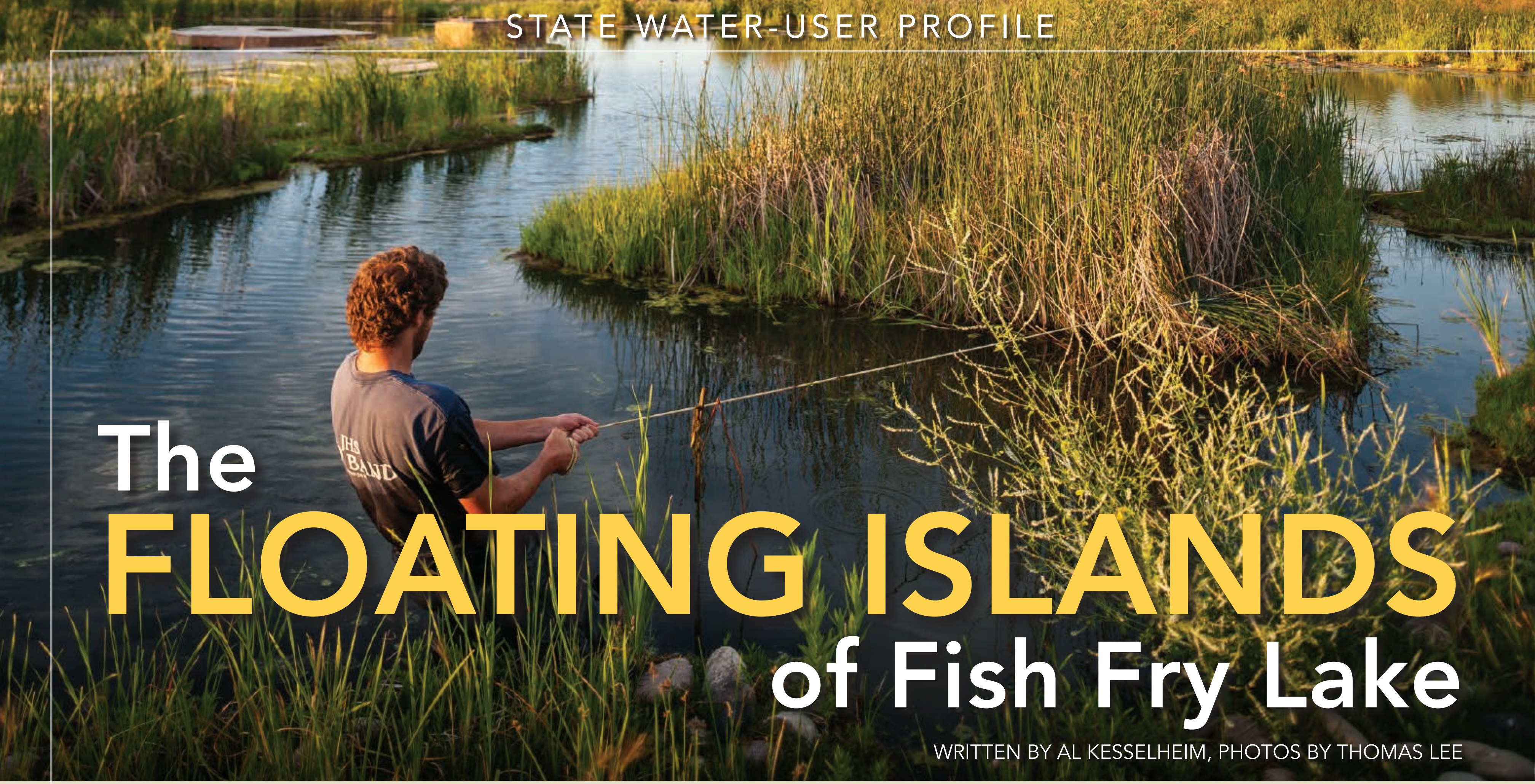


Figure 7: *Groundwater contribution to stream flows in Montana*



The FLOATING ISLANDS of Fish Fry Lake

WRITTEN BY AL KESSELHEIM, PHOTOS BY THOMAS LEE

For a guy with a passion to work on water-related issues, Bruce Kania has a pretty unbeatable perch on the world. His place, near Shepherd, sits 100 feet above the Yellowstone River, between Huntley Diversion and Pompey's Pillar. From his house the view spreads downstream over cottonwood floodplain, sandstone escarpment, looping river valley; a view that triggers images of buffalo herds and teepee encampments, or of Capt. Clark and dugout canoes heading for St. Louis.

What Kania didn't know when he brought the farmland in 1999 with money he'd made selling licenses on a couple of his inventions, was that he was inheriting a place with less than inspiring water quality. Soon after he moved in, he noticed that his black lab would emerge from a pond he'd dug near the house colored almost red and stinking so bad you couldn't get within fifty feet.

The pond was filled mostly with water diverted from the Billings Ditch, an irrigation system that starts some seventy miles upstream.

"I'm no scientist," Kania admits, "but it became my mission to do something about the water quality on my property before it drained into the Yellowstone."

In fact, Kania graduated from the University of Wisconsin with a degree in Social Studies in 1976. "Two days after graduating, I came to Montana," Kania says. He's stayed here ever since, and what he's been doing lately is working on solutions to water quality issues on his property, and now around the world.

Kania may not be a scientist, but he's smart and creative and knows how to find resources. "Back then, there were people at MSU-Bozeman who were doing some remarkable work with this stuff called biofilm," Kania remembers. "I got talking to them about what I might do to clean up my water."

That investigation led Kania to the phenomenon of floating islands, which exist naturally and act as tremendously efficient water purifiers and provide very productive aquatic habitat in the bargain.

"There are some fantastic examples in the Chippewa Flowage in northern Wisconsin," says Kania. "Some of these islands of vegetation are huge. They support entire forests, gravel beds, and develop rich habitat for an abundant fishery."

Kania has a mind always noodling with ideas, hence his success as an inventor. He started grappling with possibilities of mimicking the floating island phenomenon on his own property.

It's a long story, with the dead ends and failures typical of such quests, along with some breakthrough moments with grants and contracts, but what Kania eventually succeeded with rests on mats of shredded recycled plastic. Buoyancy is provided by foam tubes, and later, by the natural biogas bubbles emitted by biofilm and vegetation, just as in the case of natural floating islands.

From that initial concept and an endless tweaking of materials, design, manufacture, and installation techniques, Kania's idea has morphed into an amazing repertoire of applications.

One of his first contracts involved a U.S. Army Corps of Engineers project to create nesting habitat for terns. His technology furnished a 40,000 square foot island supporting 40,000 tons of sand and gravel. Floating islands are now treating sewage in Singapore, stabilizing ocean coasts against wave action, and being installed to clean water and provide productive habitat from New Zealand to Florida.

His property along the banks of the Yellowstone River continues to serve as his working laboratory and the testing ground for Kania's inventive imagination, which encompasses everything from fish fertilizer to reusing shredded carpet fibers.

Near one end of his infamous pond, which he has named Fish Fry Lake, Kania has constructed an elaborate dock. In typical fashion, Kania says, "I needed a dock. I might as well put it to work."

Putting it to work involved constructing an underwater concrete viewing room with a window eleven feet below the lake surface, building an extensive array of floating islands supporting the dock while also providing filtration and habitat functions, and adding an elevated 'streambed' that aerates water along an artificial channel on top of a long section of floating mat.

Kania boasts that Fish Fry Lake has gone from a body of water his dog emerged from as a living symbol of pollution, to the "most productive fishery in Montana." It has also gone from a reeking chemical stew to a state approaching natural balance and aerobic function from top to bottom.

"In recent tests we found no detectable levels of nitrogen and phosphorus cut in half," Kania reports.

More important, from Kania's point of view, is the potential for broad application of his floating island technology.

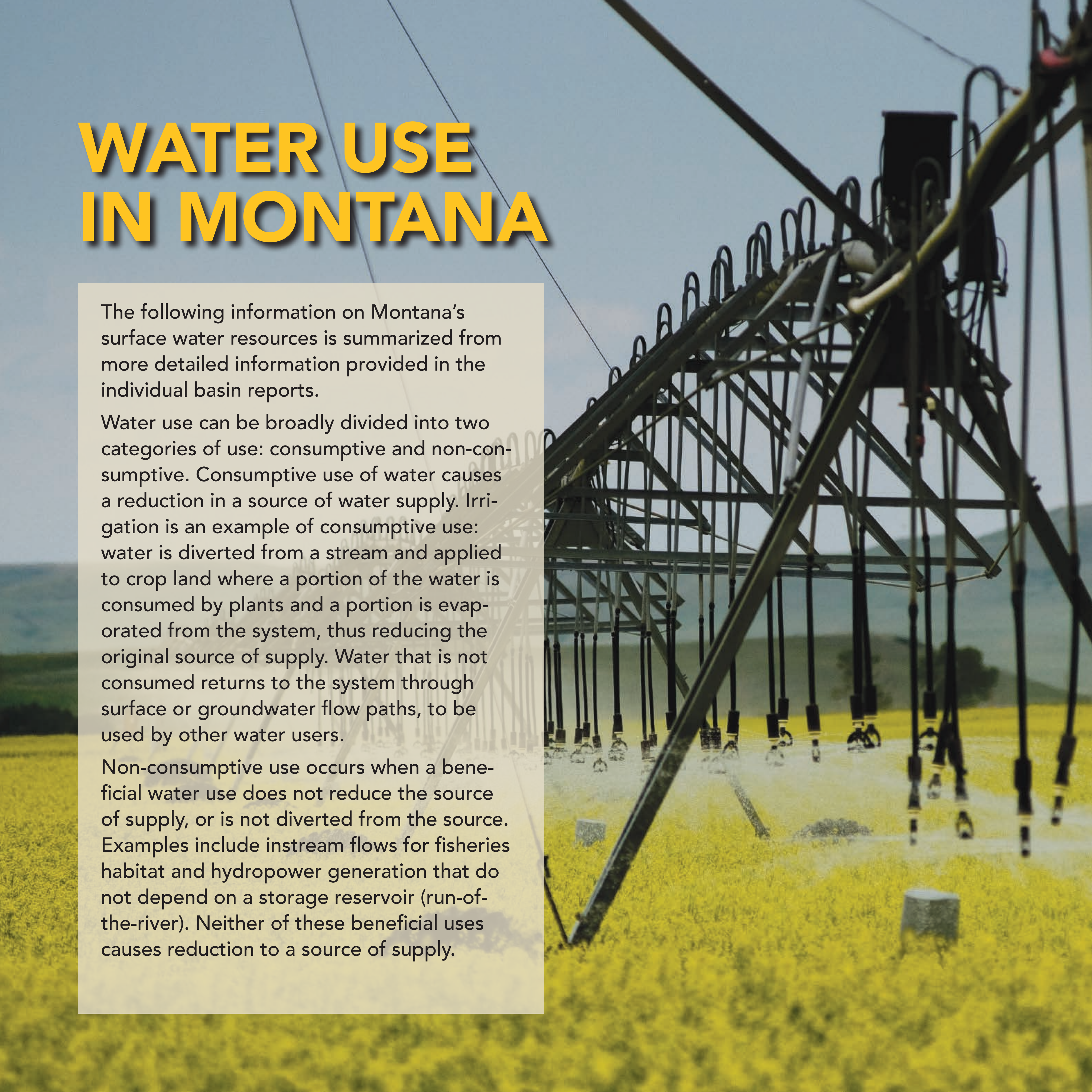
"We are very committed to Montana," says Anne Kania, Bruce's wife and business partner.

"So many of our problems come back to sick water," adds Kania. "I'm developing small floating islands that can be dropped into puddles and ponds to mitigate everything from mosquito and midge infestations to West Nile and hemorrhagic disease in deer populations."

"This is a vision of hope," emphasizes Kania. "It's a vision of abundance. We've been in a long downward spiral of water quality in this country, but we can reverse that. We know how to do it right now." ■

"I'm no scientist, but it became my mission to do something about the water quality on my property before it drained into the Yellowstone."

—Bruce Kania



WATER USE IN MONTANA

The following information on Montana's surface water resources is summarized from more detailed information provided in the individual basin reports.

Water use can be broadly divided into two categories of use: consumptive and non-consumptive. Consumptive use of water causes a reduction in a source of water supply. Irrigation is an example of consumptive use: water is diverted from a stream and applied to crop land where a portion of the water is consumed by plants and a portion is evaporated from the system, thus reducing the original source of supply. Water that is not consumed returns to the system through surface or groundwater flow paths, to be used by other water users.

Non-consumptive use occurs when a beneficial water use does not reduce the source of supply, or is not diverted from the source. Examples include instream flows for fisheries habitat and hydropower generation that do not depend on a storage reservoir (run-of-the-river). Neither of these beneficial uses causes reduction to a source of supply.

Water use in Montana totals 84,000,000 acre-feet annually (Figure 8). The great majority of this amount is used for electric hydropower generation. The large water rights associated with hydropower facilities may limit additional consumptive use in their respective basins. In Montana, hydropower generation during 2010 used 72,000,000 acre-feet of water annually; about 86 percent of all water used in the state.

Of the remaining 12,000,000 acre-feet, 3,600,000 acre-feet are actually consumed (see Figure 10). Of this amount, reservoir evaporation totals approximately 1,000,000 acre feet (28 percent) statewide. Agricultural irrigation consumes about 2,400,000 acre feet, or about 68 percent of the water consumed in Montana. The remaining approximately 200,000 acre feet are consumed by all other uses including municipal, industrial, domestic, and livestock watering.

The most recent state-wide assessment of water use in Montana was conducted in 2000 by the USGS in cooperation with DNRC. The results of this assessment are published in the report *Estimated Water Use in Montana in 2000* (USGS, 2004). Since that time, DNRC has developed procedures for estimating water use on smaller, source by source scale to fulfill its role in permitting new uses of water and change applications.

In areas of Montana, the ability to put water to a beneficial use is limited as much by water quality as physical availability. Water quantity and water quality are closely intertwined and the Montana Water Use Act recognizes this relationship (§85-2-311 MCA). However, this document offers limited guidance regarding water quality issues because DNRC has no authority to regulate water quality and the state water planning

WATER USE IN MONTANA ANNUAL ACRE FEET

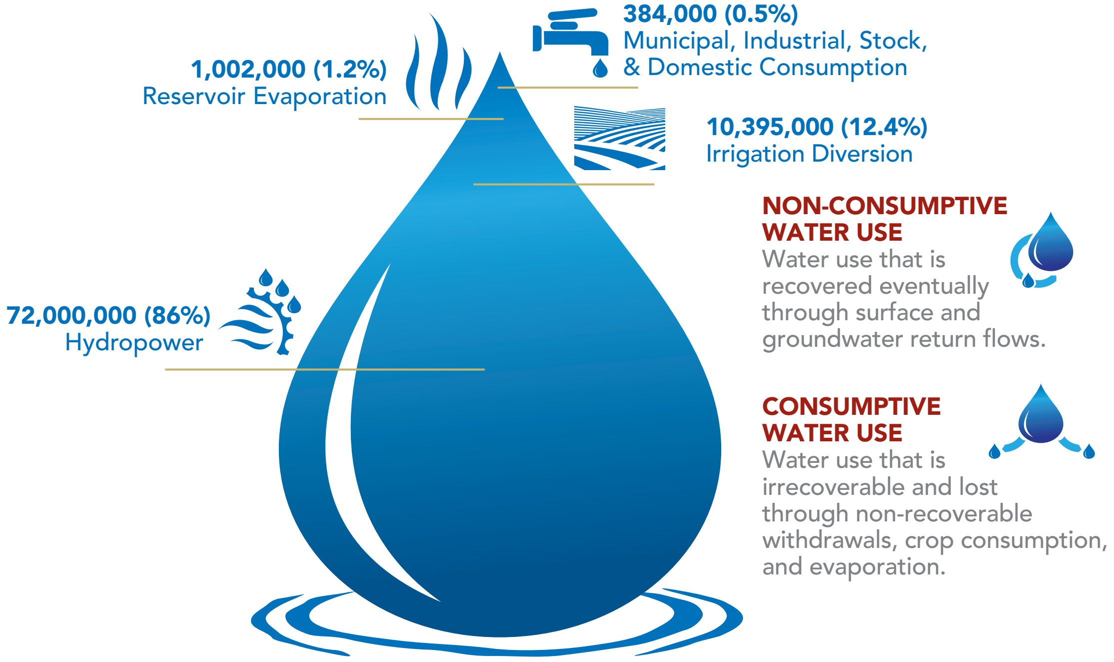


Figure 8: *Water Use in Montana by purpose*

statute does not explicitly address water quality. The Department of Environmental Quality has primary authority over the regulation of water quality in Montana. For more information on water quality regulation in Montana, please reference DEQ's Montana Nonpoint Source Management Plan at http://deq.mt.gov/wqinfo/nonpoint/NonpointSourceProgram.mcpx). Another good source of information is the Clean Water Act Information Center http://deq.mt.gov/wqinfo/CWAIC/default.mcpx. These sites provide information, strategies and goals and reports that address water quality issues generally as well as water quality as it is affected by water quantity.

Decision making and policy development both in the legislature and DNRC would benefit from information generated by an updated assessment of statewide water use. Conducting a statewide assessment will require Montana to make investments in monitoring infrastructure, computer information technology and staff resources.

SUMMARY AND COMPARISON OF WATER USE BY PLANNING BASIN

Type and volume of water use varies between Montana basins (Figures 9a, 9b, 9c, 9d). Return flow, water that is diverted but returns to the source, is a critical factor in basin water use. Each water user relies to some extent on return flow from water uses further upstream. As a result, the net volume of water diverted in a basin is less than the volume of all the individual diversions. Figures 9a, 9b, 9c, and 9d depict water uses at a planning basin scale and do not include water uses that are important at sub-basin scales. For example, the Figure 9a for the Clark Fork / Kootenai River planning basin does not depict the instream flow water use for recreation in the Bitterroot sub-basin.

CLARK FORK/KOOTENAI RIVER BASIN WATER USE
ANNUAL ACRE FEET

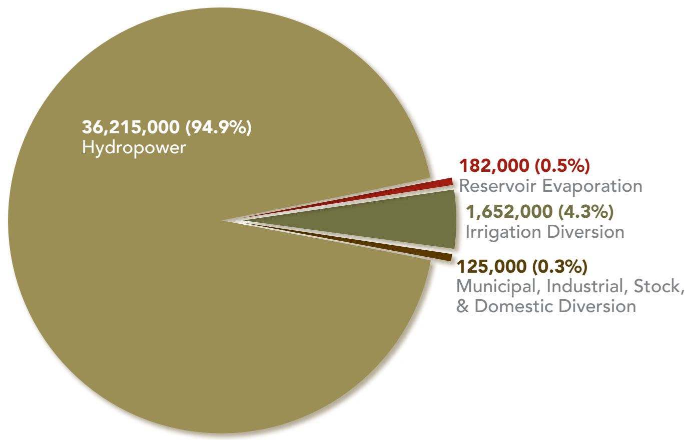


Figure 9a: *Clark Fork/Kootenai River Basin Water Use*

UPPER MISSOURI RIVER BASIN WATER USE
ANNUAL ACRE FEET

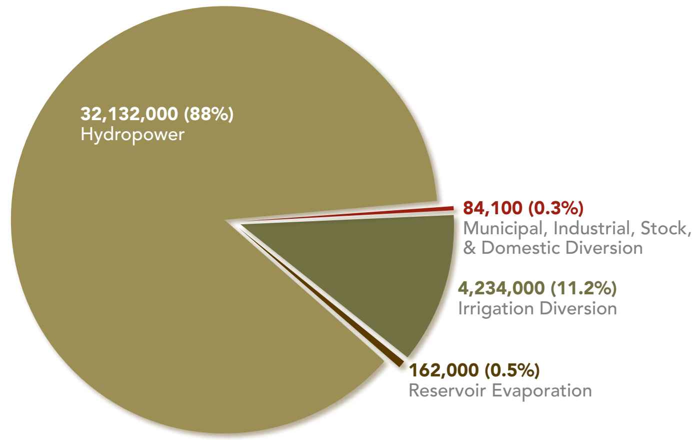


Figure 9b: *Upper Missouri River Basin Water Use*

The largest use of water in the Clark Fork Basin is for hydroelectric power generation at Avista Corporation's Noxon Rapids Dam (and reservoir), near the Idaho border (Figure 9a). Irrigated agriculture is the second largest user of water at over 1.6 million acre feet annually. All other uses of water in the basin use approximately 307,000 acre-feet annually.

Hydroelectric power generation is also the largest use of water in the Upper Missouri River Basin (Figure 9b). Irrigated agriculture diverts over 4 million acre feet annually. The cities of Helena, Great Falls and Bozeman use about 84,000 acre-feet annually. Canyon Ferry, Clark Canyon, Tiber and other major reservoirs annually evaporate over 160,000 acre feet of water combined.

In the Lower Missouri River Basin, irrigation diverts approximately 2 million acre feet annually, proportionately more water than either the Clark Fork or Upper Missouri River basins though less than in the Yellowstone basin (Figure 9c). Reservoir evaporation is substantial from the surface of Fort Peck Reservoir. The only hydroelectric facility in the lower basin, Fort Peck used just over 4 million acre feet of water to generate power in 2010. Montana Fish Wildlife and Parks (FWP) manages an instream flow rights of 5,000 cfs (3.6 million acre feet) just downstream of the dam and below the Milk River confluence with the Missouri River for fisheries, wildlife, and recreational uses. Other uses in the sparsely populated area total less than 30,000 acre feet diverted annually.

LOWER MISSOURI RIVER BASIN WATER USE
ANNUAL ACRE FEET

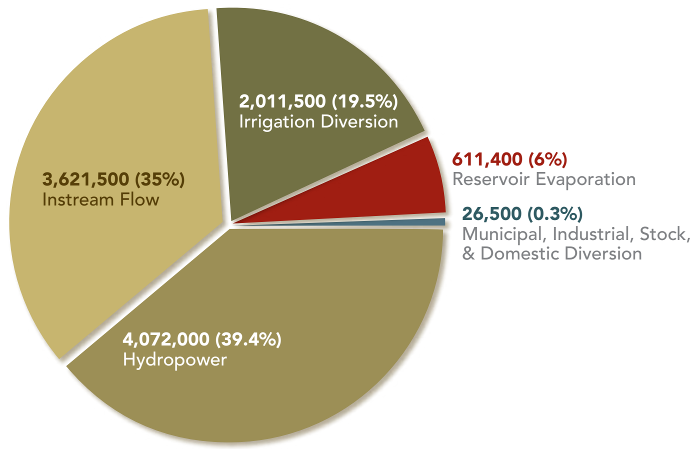


Figure 9c: *Lower Missouri River Basin Water Use*

YELLOWSTONE RIVER BASIN WATER USE
ANNUAL ACRE FEET

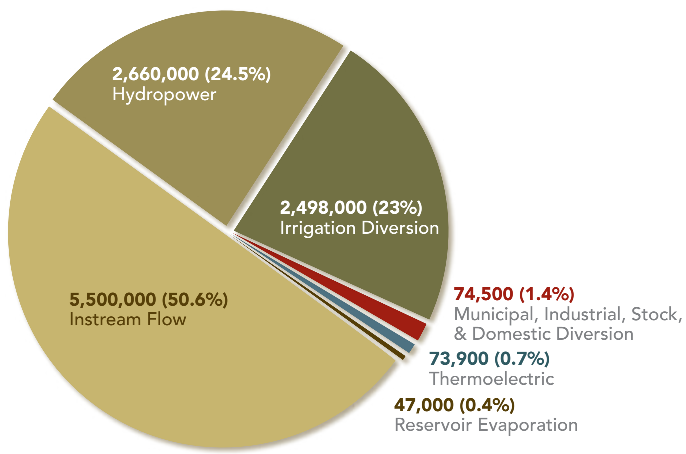


Figure 9d: *Yellowstone River Basin Water Use*

With the largest city in the state Billings, Yellowstone Basin has the highest municipal and industrial water use in the four MWSI planning basins (Figure 9d). Irrigation diverts approximately 2.5 million acre feet annually to serve over 600,000 acres. Hydroelectric power generation uses almost 2.7 million acre feet at Yellowtail Dam on the Bighorn River near the Wyoming border. Montana FWP manages an instream flow right of 5.5 million acre feet for the Yellowstone River at Sidney.

INVENTORY OF CONSUMPTIVE WATER USE

Consumptive water use in Montana is influenced by a variety of factors including irrigated acreage, physically available water supplies, number of stock, and population. The water volume consumed by any use is less than the volume initially diverted, and the unused portion of water eventually returns to the system to be used by others. In Montana, basin-wide total consumption amounts to less than 30 percent of the diverted total, when considering all uses combined. Figures 10, 11a, 11b, 11c, and 11d show estimates of water consumed by type of use from information presented in individual planning basin documents. These estimates are of use for 2010 (2007 for irrigation) based on methodology described in individual basin plans.

WATER CONSUMED IN MONTANA
ANNUAL ACRE FEET

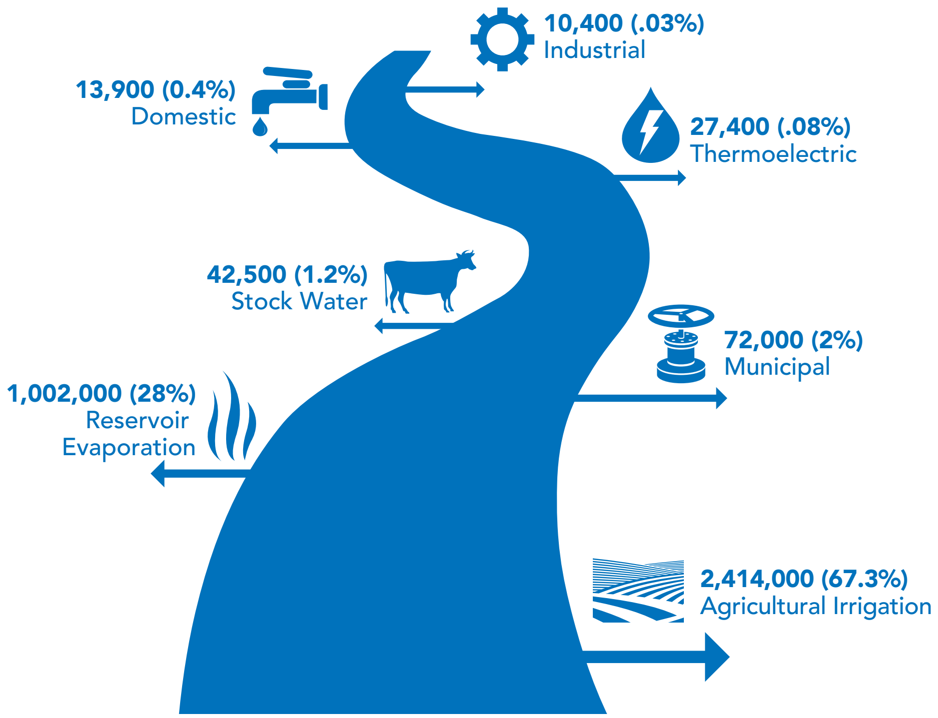


Figure 10: *Water Consumption in Montana by Purpose*

CLARK FORK/KOOTENAI RIVER BASIN CONSUMPTIVE WATER USE ANNUAL ACRE FEET

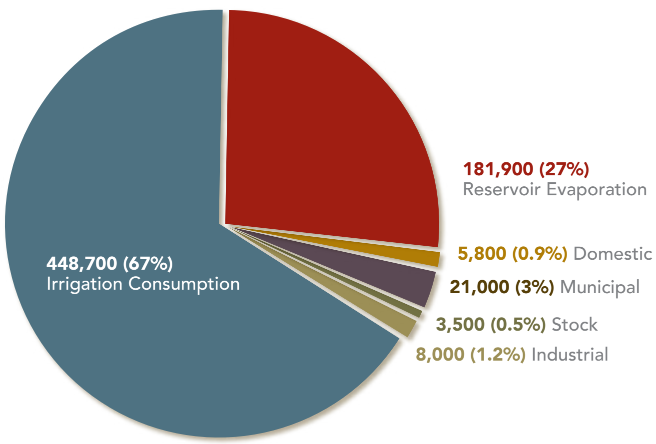


Figure 11a: *Clark Fork/Kootenai River Basin Water Consumption*

UPPER MISSOURI RIVER BASIN CONSUMPTIVE WATER USE ANNUAL ACRE FEET

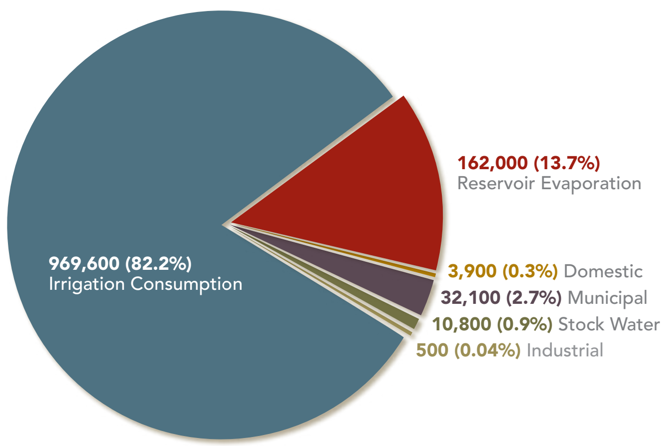


Figure 11b: *Upper Missouri River Basin Water Consumption*

LOWER MISSOURI RIVER BASIN CONSUMPTIVE WATER USE ANNUAL ACRE FEET

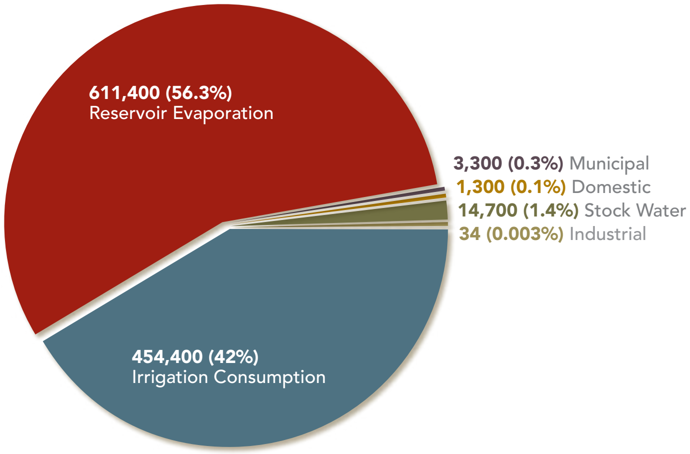


Figure 11c: *Lower Missouri River Basin Water Consumption*

YELLOWSTONE RIVER BASIN CONSUMPTIVE WATER USE ANNUAL ACRE FEET

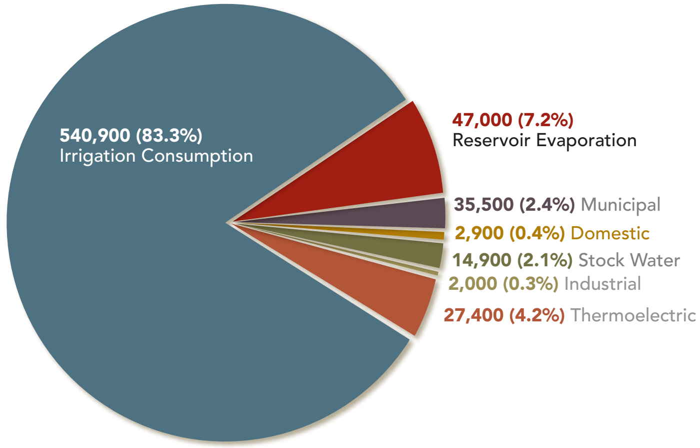


Figure 11d: *Yellowstone River Basin Water Consumption*

Irrigated Agricultural Water Use

Agricultural irrigation is the largest consumptive use of water in Montana. Estimates of water use presented in individual basin plans indicate that 10.4 million acre feet are diverted for agricultural irrigation on approximately 2.5 million acres each year. This amount accounts for 96 percent of all surface and groundwater diverted or withdrawn for any consumptive use statewide (Table 1). Montana's irrigated crops include alfalfa, barley, cherries, corn, grass, oats, potatoes, sugar beets, and wheat. Agricultural water use varies across the state and is affected by climate, geology and soils, and proximity to water. DNRC estimated agricultural water use consumption for 8 digit HUCs (Figure 12) by identifying potentially irrigated acreage and estimating consumptive use and acreage actually irrigated using Landsat satellite images. Potentially irrigated acreage was identified from multiple sources including Water Resource Surveys, the Department of Commerce Final Lands Unit (FLU) data, and mapping conducted under a variety of investigations including those for reserved water right compacts. Analysis of Landsat images was used to screen out lands that did not appear to be irrigated and to provide estimates of evapotranspiration and crop water demand.

Table 1: *Water Use for Agricultural Irrigation in Montana, from Surface Water and Groundwater Sources.*

Planning Basin	Diverted (AF)	Percent of Basin Total Diverted	Consumed (AF)	Percent Diverted Consumed
Clark Fork River	1,652,000	95%	449,000	27%
Upper Missouri River	4,234,000	99%	969,600	23%
Lower Missouri River	2,011,000	99%	454,400	23%
Yellowstone River	2,498,000	97%	541,000	22%
Total	**10,395,000**	**96%**	**2,414,000**	**23%**

Table 2: *Water Use for Stock Watering, and Public Water Supply from Surface Water and Groundwater in Montana*

Planning Basin	Stock Water Consumed (AF)	Stock Water % of Total Consumed	Public Supply Consumed (AF)	Public Supply % of Total Consumed
Clark Fork River	3,500	0.7%	20,970	4.3%
Upper Missouri River	10,830	1.1%	32,165	3.2%
Lower Missouri River	14,720	3.1%	3,290	0.7%
Yellowstone River	13,470	2.2%	15,650	2.6%
Total	**42,520**		**72,075**	

Livestock Water Use

Water for livestock (Table 2) is one of the larger consumptive uses of surface water in Montana. For example, stock watering in the Lower Missouri River Basin accounts for three percent of all surface water consumed, while public water systems account for less than one percent of total surface water consumption. The number of livestock (cows, sheep, hogs) was taken from National Agricultural Statistics Service data for 2010. Water withdrawn was estimated using the assumptions applied in the 2000 USGS report *Estimated Water Use in Montana* (USGS, 2004): Beef Cattle –15 gpd/head, Dairy Cattle – 23 gpd/head, Swine – 5 gpd/head, Sheep – 2 gpd/head.

Opportunities for Research and Investment

Future water resource planning and policy development will be enhanced if Montana invests the time and resources to acquire more accurate information on the extent and distribution of irrigated lands, extent and distribution of crop types, irrigation system types and consumptive water use. To achieve this, investments would be needed in the following three areas:

1. Geographic Information System (GIS) technology to analyze commercially available aerial photography and satellite imagery.
2. Computer modeling software to calculate the amount of water consumed by crops (evapotranspiration) using commercially available information generated from NASA's Landsat Program and data from the USBR Agri-Met Program.
3. Staff resources to conduct the inventory and survey, analyze the information and ground truth the results.

Public Water Supply and Self-Supplied Domestic

Consumption through public water supply systems from surface water and groundwater totals about 72,000 acre feet statewide (Table 2). More than half of the volume for public water supply systems comes from surface water sources. The exceptions are in the Clark Fork and Lower Missouri River basins. High quality surface water supplies are scarce in the Lower Missouri River Basin and many residents rely on groundwater for domestic water supplies. Both surface and groundwater supplies are used to supply a large and growing population in the Clark Fork Basin. Self-supplied domestic uses of groundwater consume an additional 14,000 acre feet of water statewide.

Consumptive use by public water supply systems was assumed to be 37% of withdrawals (DNRC, 1975; USGS, 1986). One exception is the City of Butte, which withdraws water from the Big Hole River for use in the Upper Clark Fork River Basin. In this case, all water withdrawn from the Big Hole River is assumed to be consumed. Consumptive use by self-supplied domestic for combined in-house and lawn irrigation was assumed to be 50% of withdrawals.

STATEWIDE IRRIGATION CONSUMPTION BY 8 DIGIT HYDROLOGIC UNIT

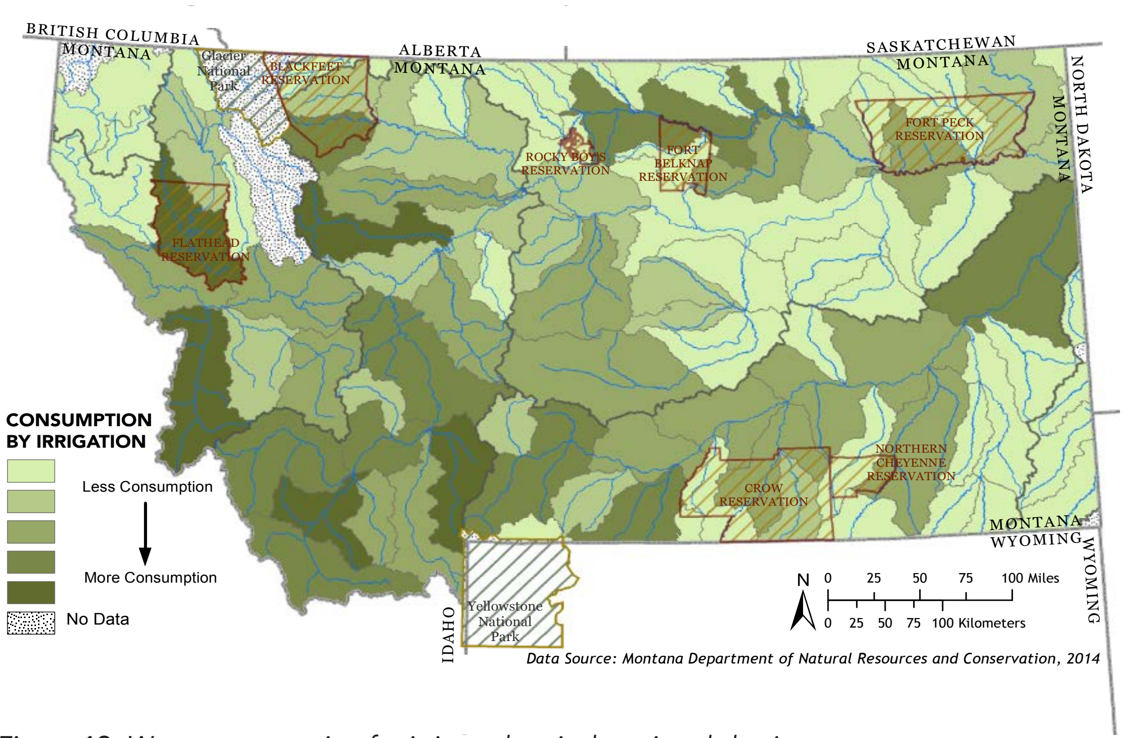


Figure 12: *Water consumption for irrigated agriculture in sub-basins*

Industrial Water Use

More than 75 percent of water consumed for industrial purposes in Montana occurs within four counties: Flathead, Missoula, Lincoln, and Yellowstone. Statewide, industrial water consumption totals less than 10,500 acre-feet annually. Approximately 8,000 acre feet are used in the Clark Fork Basin and 1,800 acre feet are used in the Yellowstone Basin. Major uses of industrial water in Montana are for oil and gas stimulation and recovery, processing of minerals, processing agricultural products, and manufacturing. Water use for hydraulic fracturing to stimulate oil production in horizontal wells is locally significant in the Williston Basin near the North Dakota border and potentially other areas including central Montana and the Rocky Mountain front. Water use for fracking and refracking has been reported in the range of 10 to 25 acre feet over the life of one well; however, actual use varies depending on many variables including geologic conditions and company operating practices. The Montana Board of Oil and Gas Conservation on-line database indicates that an average of 140 horizontal wells have been completed in Montana annually over the ten years ending in 2013 corresponding to potential annual water use from 1,400 acre feet to 3,500 acre feet. Both surface water and groundwater are important sources for industrial water users.

Data on industrial water use were developed using information compiled by the USGS. USGS estimates from 1985 through 2000 broken out by county and watershed were analyzed to determine where the majority of the water use occurred. Updated estimates representing 90% of the statewide industrial water use were then developed using 2005 USGS data reported by county only. All other industrial use estimates remain as reported by USGS in *Estimated Water Use in Montana* (USGS, 2004).

Reservoir Evaporation

Water storage in reservoirs is an important component of water management in Montana, helping to supply water during peak summer demand (Figure 13). But reservoirs lose a large amount of water to surface evaporation, a form of consumptive use. In the arid Lower Missouri River Basin, which includes Fort Peck Lake, reservoir evaporation is greater than all other consumptive uses combined, totaling more than 611,000 acre-feet a year, or about 6 percent of the basin water budget.

Evaporation from reservoirs total 162,000 acre-feet in the Upper Missouri Basin, 182,000 acre-feet in the Clark Fork and Kootenai Basins combined, and 47,000 acre-feet in the Yellowstone. Reservoirs in the Wyoming portion of the Yellowstone Basin evaporate about an additional 150,000 acre-feet.

Evaporation estimates are taken directly from the USGS report *Estimated Water Use in Montana* (USGS, 2004) which were calculated using surface areas from the USGS (Ruddy and Hitt, 1990), evaporation rate from the 1982 NOAA map (based on 1956-1970 pan data), and 1961-1990 PRISM data. In a few cases, where sufficient data was available, USGS values were compared to estimates developed using a water balance approach.

INVENTORY OF NON-CONSUMPTIVE WATER USE IN MONTANA

Hydroelectric Rights

Statewide, a total of 22 dams in Montana generate hydropower (Figure 14). Hydroelectric water rights are present in all four of the MWSI

MONTANA RESERVOIRS >5,000 ACRE-FEET

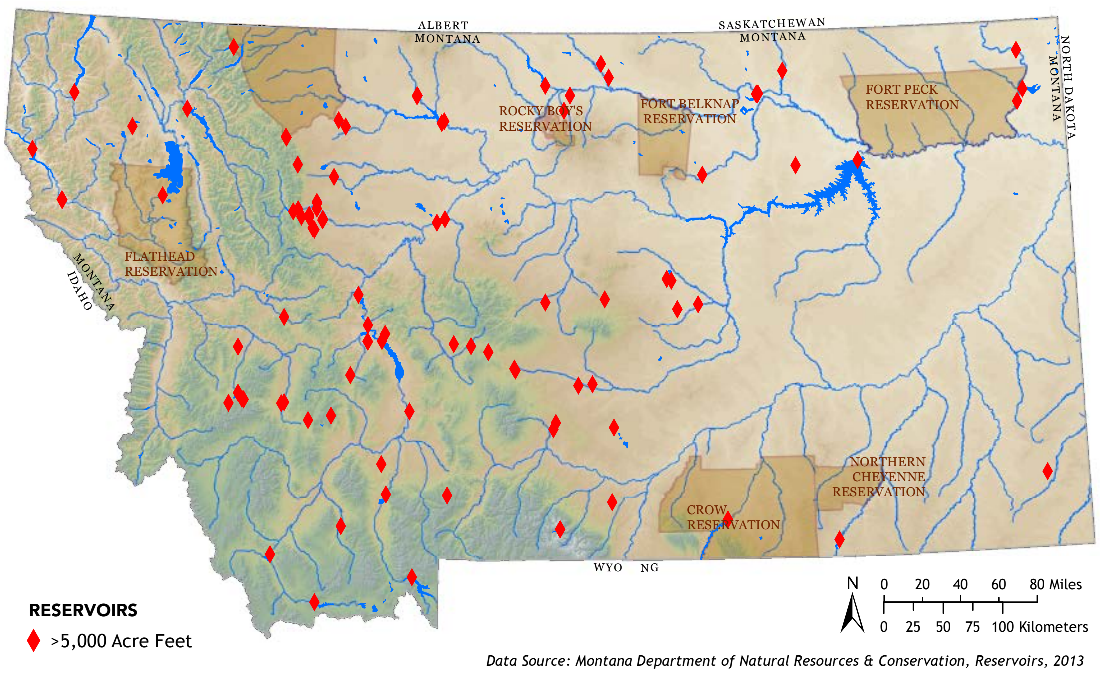


Figure 13 *Reservoirs in Montana with greater than 5,000 acre-feet capacity*

planning basins, but are predominant in the Clark Fork and Upper Missouri river basins. Although hydroelectric generation is a non-consumptive use, water rights for several of these dams, due to their size and priority date, constrain the legal availability of water for future consumptive uses in the basins upstream from their locations.

Hydropower water rights for Avista Corporation's Noxon Rapids Dam on the Clark Fork River near the Idaho border constrain the legal availability of water available for future consumptive use in the Clark Fork Basin. Avista's water rights have priority dates of 1951, 1959, and 1974, and total 50,000 cfs (Figure 15).

The Upper Missouri Planning Basin contains 10 hydroelectric facilities (Table 3). The water rights associated with these facilities serve as a constraint on the legal availability of water to meet future consumptive uses in the basin upstream of Morony Dam near Great Falls. Development of new water rights above these facilities was effectively precluded after 1954 when the Bureau of Reclamation constructed Canyon Ferry Dam. Montana Power (now NorthWestern Energy) and Reclamation entered into an agreement that provided for Montana Power's water rights to be met from regulated releases from Canyon Ferry storage. This allowed for additional water development in the Missouri Basin including the construction of Clark Canyon Dam and the development of the East Bench Irrigation district. According to Reclamation staff, additional water remains in Canyon Ferry Reservoir that could be marketed for a multitude of purposes, provided that Federal and State environmental laws are followed.

MONTANA HYDROELECTRIC DAMS

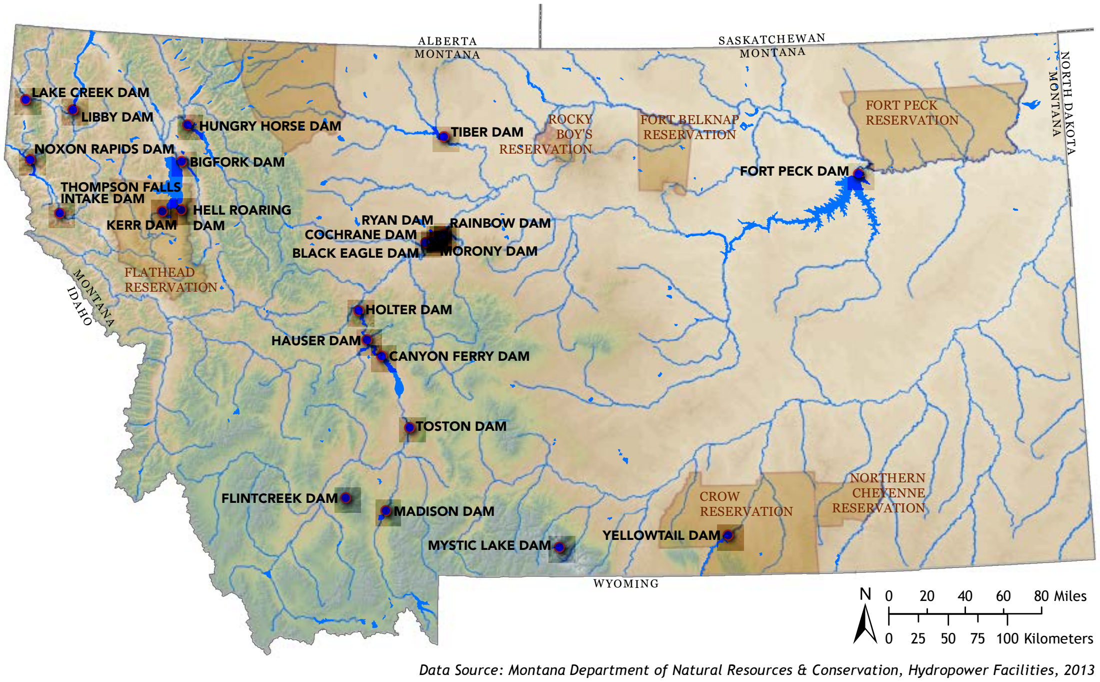


Figure 14: *Hydroelectric projects in Montana*

CLARK FORK RIVER AT NOXON HYDROGRAPH

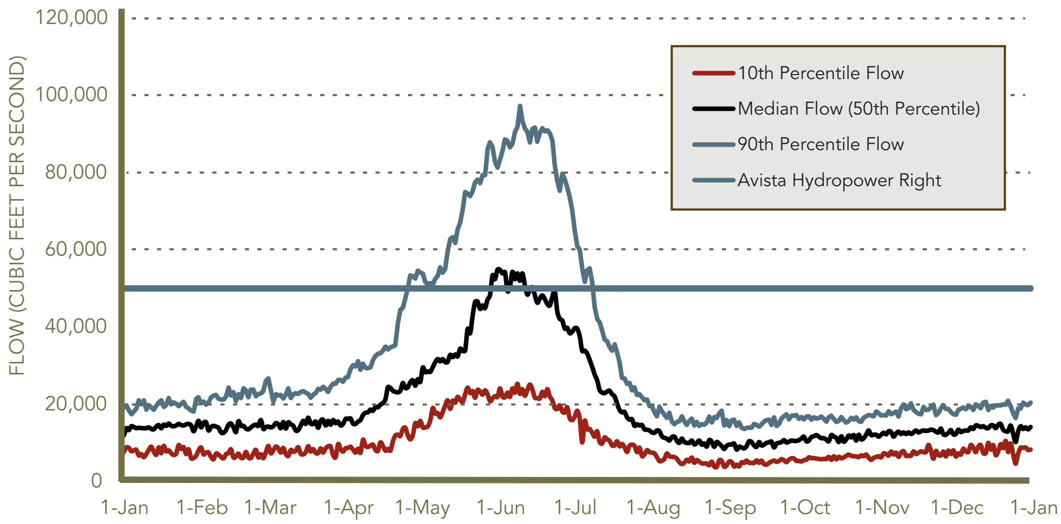


Figure 15: *Hydrograph of Clark Fork River at Noxon with Avista hydroelectric water right*

Table 3: *Hydroelectric generation facilities in the Upper Missouri planning basin above Morony Dam*

Owner/Operator	Facility	Water Right (cfs)	Generation Capacity (MW)
NorthWestern Energy	Morony Dam	8,280	48
NorthWestern Energy	Ryan Dam	5,900	60
NorthWestern Energy	Cochrane Dam	10,000	64
NorthWestern Energy	Rainbow Dam	8,000	60
NorthWestern Energy	Black Eagle Dam	5,040	21
NorthWestern Energy	Holter Dam	7,100	48
NorthWestern Energy	Hauser Dam	4,740	19
NorthWestern Energy	Madison Dam	1,650	9
U.S. Bureau of Reclamation	Canyon Ferry Dam	6,390	58
State of Montana/DNRC	Toston Dam	7,200	10

Additional hydroelectric facilities in the Upper Missouri Planning Basin include Turnbull Project which generates 13 MW of electricity from irrigation canals in the Greenfield Irrigation District, and a 7.5 MW generating facility at Tiber Reservoir.

The Yellowstone Planning Basin contains two hydroelectric facilities of significant size. The U.S. Bureau of Reclamation's Yellowtail Dam on the Big Horn River has a storage capacity of 1,381,189 acre-feet with a generation capacity of 250 MW. NorthWestern Energy operates Mystic Lake Dam a two-unit hydroelectric plant on the West Rosebud Creek in the Beartooth Mountains with a generating capacity of 12 MW. The reservoir behind the dam has a storage capacity of 21,000 acre feet.

Hydroelectric generation in the Lower Missouri Planning Basin is dominated by the U.S. Army Corps of Engineers Fort Peck Dam. The facility's five generators have a combined generation capacity of 185.25 MW. Ft Peck Reservoir has a storage capacity of 18,463, 000 acre-feet making it the fifth largest man-made lake in the U.S.

INSTREAM FLOW RIGHTS

Montana's rivers are well known for their outdoor recreational opportunities and for world-class fisheries. As a result, non-consumptive water rights, which keep water instream to protect fisheries, wildlife, and recreational uses are fairly widespread. FWP also holds a number of pre-1973 instream flow rights for recreation.

Murphy Rights

In 1969, Jim Murphy of Kalispell sponsored legislation to provide instream flow protection for specified rivers in Montana. "Murphy Rights" were approved by the Legislature for 12 of Montana's Blue Ribbon trout streams. These rights have a December, 1970, priority date and provide instream flow protection to the following rivers against additional consumptive water use: Madison, Gallatin, Missouri, Smith, Big Spring Creek, Blackfoot, Flathead, West Gallatin, Rock Creek, Yellowstone, Middle Fork Flathead, and South Fork Flathead.

Recreational Water Rights

Recreational water rights are held by FWP to maintain instream flows necessary for public recreational uses. In the Clark Fork and Kootenai Basins, these rights are limited to the Bitterroot River and several lakes in the Clearwater and Blackfoot drainages.

In the Upper Missouri River Basin, FWP holds a public recreation claim for 200 cfs in the Beaverhead River from Grasshopper Creek to Clark Canyon Dam, as well as a fish and wildlife claim for 25 cfs from Clark Canyon downstream to the confluence with the Big Hole River. These claims are relatively junior, with priority dates of August 29, 1964, and February 28, 1962, respectively. FWP also holds a year-round public recreation claim for 1,946,624 acre feet in Canyon Ferry Reservoir with a priority date of May 24, 1949.

Instream Flow Leasing

In 1989, FWP received limited authority to temporarily lease or convert a water right to instream flow. In 1995, the Legislature extended authority to a water right owner to convert their right to instream flow, or lease the water right to a private third party for instream flow. A lease for instream flow may be entered for a term up to 10 years. All leases may be renewed an indefinite number of times, but not for more than 10 years for each term. A lease up to 30 years is allowed if the leased water is made available from the development of a water conservation or storage project.

Water Reservations

In 1992, FWP was granted water reservations for minimum instream flows for 245 streams or stream reaches in the Upper Missouri River Basin. The reservations are intended to provide some protection to fisheries, wildlife, and recreational use values, and they have a priority date of July 1, 1985. FWP was granted similar flows for 13 streams in the Lower Missouri River Basin. A complete summary of all FWP instream flow reservations in the

Upper and Lower Missouri River Basins is presented in the individual basin reports.

The Bureau of Land Management (BLM) has instream flow reservations for 31 smaller streams on BLM lands in the Missouri River headwaters. A summary of BLM reservations is presented in the basin reports. These reservations, which include year-round minimum flows and peak discharges for stream channel maintenance, also have a July 1, 1985, priority date.

In 1979, the Yellowstone River Reservations process reserved FWP instream flow rights for a large number of streams in the Yellowstone Basin. These reservations vary by month, generally following seasonal flow patterns.

DEQ Water Reservations

The Montana Department of Environmental Quality (DEQ) reserved instream flows to maintain water quality on the upper Missouri and Yellowstone Rivers. For the upper Missouri River, the purpose of the reservation is to dilute naturally occurring arsenic, which primarily originates from geothermal springs in Yellowstone National Park. The reservations are for one-half the average annual flow of the Missouri River at four locations as summarized in the basin reports, and have a July 1, 1985, priority. For the Yellowstone River, the DEQ reservations are for the 80th percentile of monthly flows less depletions from other reservations evaluated at Livingston, Billings, Miles City, and Sidney. The DEQ reservations run concurrently with the FWP instream flow reservations.

Federal Water Rights Compacts

U.S. DEPARTMENT OF THE INTERIOR, BUREAU OF LAND MANAGEMENT (BLM)

An agreement between Montana and the BLM quantifies instream flow rights for the Bear Trap Canyon Public Recreation area, the Upper Missouri National Wild and Scenic River (UMNWSR) and the Upper Missouri River Breaks National Monument. For Bear Trap Canyon below Madison Dam, BLM has a priority date of June 9, 1971, for a flow of 1,100 cfs year-round. The UMNWSR water right is for the amount of river flow remaining instream after satisfying all appropriations earlier than December 31, 1987. Additional depletions are specified by month, and small domestic and stock wells, lawn and garden, and instream stock uses are also allowed without counting against the totals. The Upper Missouri River Breaks National Monument compact subordinates the United States' 2001 priority date to June 1, 2012, quantifies an instream flow right of 160 cfs and 5 cfs in the Judith River and Arrow Creek respectively, institutes an on-stream impoundment limitation, and requires ramping of large new diversions.

U.S. DEPARTMENT OF AGRICULTURE FOREST SERVICE

This compact between Montana and the Forest Service was approved by the Montana Legislature and approved by the Governor in 2007. The compact recognizes federal reserved water rights for the Forest Service for administrative and emergency firefighting, and for instream flows for the South Fork Flathead Wild and Scenic River. The compact also provides a mechanism for the Forest Service to apply for new state based instream flow reservations on Forest Service land.

U.S. DEPARTMENT OF THE INTERIOR FISH AND WILDLIFE SERVICE

A compact between the US Fish and Wildlife Service (FWS) and the state settles rights for the Charles M. Russell, Black Coulee, Benton Lake, and Bowdoin national wildlife refuges. The Charles M. Russell refuge almost entirely surrounds Fort Peck Reservoir and includes many small tributaries. The compact recognizes instream base flow rights of ½ cfs or 1 cfs in 68 named streams draining into the refuge to benefit stock, wildlife, and wildlife habitat. The compact also reserves an instream right of 70 cfs for the Musselshell River where the river enters the refuge. These rights run concurrently with the FWP rights of the same magnitude. The priority date for the CMR Compact is December 11, 1936.

UNITED STATES NATIONAL PARK SERVICE

A compact between Montana and the National Park Service executed on January 31, 1994, established instream flow rights associated with Yellowstone and Glacier National Parks, Big Hole Battlefield, Little Bighorn Battlefield National Monument, and Bighorn Canyon National Recreation Area. These instream flow rights are tailored to the unique character of these areas, but typically include instream flows on streams where they flow within or form the boundary to Park Service lands. The compact allows for a certain level of consumptive use to which the United States agrees to subordinate its reserved instream flow water right.

Walking Fence Lines

The Challenge of History, Culture, and Jurisdiction in the Jocko

WRITTEN BY AL KESSELHEIM, PHOTOS BY THOMAS LEE

Kerry Doney is a man who embodies the demographics of his land. He lives just south of Arlee, in the Jocko River valley, where he currently serves as water commissioner for the Jocko Irrigation District and sits on the Clark Fork Task Force.

On his father's side, his lineage goes back to the homestead days, generations deep in ranching and logging. On his mother's side, he is Pend d'Oreille, an enrolled member of the Salish and Kootenai Tribes of the Flathead Nation. His dad grew up along nearby Doney Road, while his mom lived just half a mile from Doney's current home on Agency Road. Many of his family members still live in the valley. To say that Doney is embedded in his landscape is an understatement. He refers to a neighboring landowner who has lived there for 30 years as a newcomer.

Doney is soft-spoken, his handshake gentle, his face earnest. His home is modest and tidy, the ranch yard neat, full of pickup trucks, tractors, fuel tanks. It is early summer—the grass rich green, the willows leafed out, blackbirds raucous in the fields. The peaks up the drainage are still covered in snow. It looks like a good year for water.

"Ever since I was seven or eight," Doney says, "I was always on a tractor or riding a horse or fixing fence.

"By the time I graduated from high school, I had my own herd of twenty cattle. I hired my high school teachers to buck hay for me in the summers. Didn't seem to help my grades any," he laughs.

Doney now manages roughly 1,000 acres, a combination of his land, leased ground, and his mother's acreage. That land falls into a medley of categories, from 'fee land' to 'trust land' and some 'secretarial land'. "I'm fairly typical," he says.

The Jocko District is fed by water supplied by a series of small reservoirs, including Jocko Lakes and Black Lake, along with the flows from tributary streams. It is tribal water, administered through a federal agreement overseen by the Bureau of Indian Affairs. Tribal water is allocated just like irrigation water anywhere in Montana, but depending on the status of a given property, it falls into one of several categories.

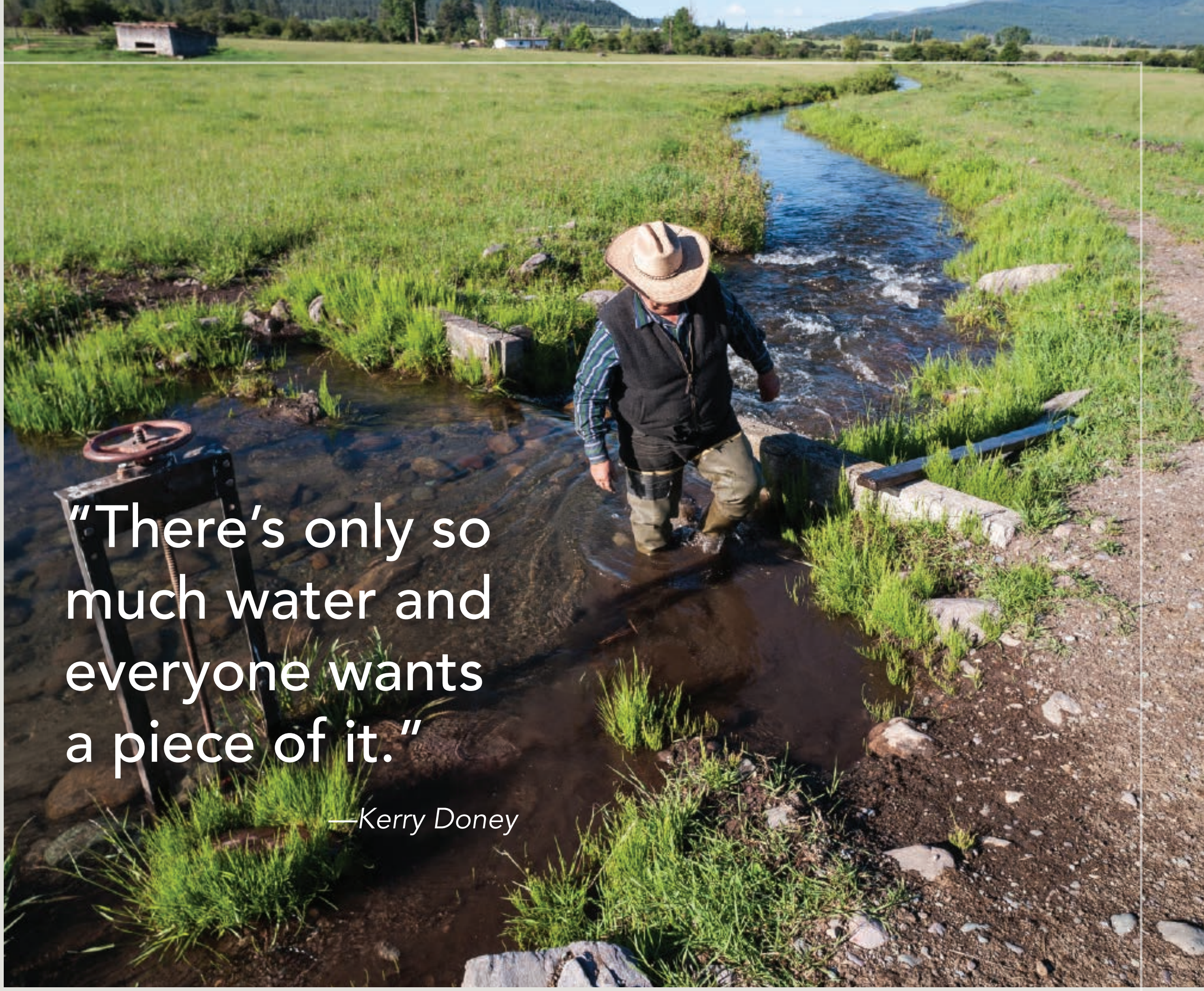
Trust lands are acres held for tribal members by the federal government. Fee lands refer to property with assessed fees for water use and administrative costs. Secretarial land predates the irrigation district and is subject to a different fee rate. What Doney refers to as non-district land is acreage in a kind of limbo status, where the courts have yet to settle the legal designation.

More than 7,000 acres in the Jocko District are fee lands, split up among more than 400 users, some of whom irrigate as little as two or three acres.

"We don't have enough water storage to fill all of our water rights," says Doney. "We use water until it's gone."

That takes some paying attention. On his property, for example, Doney closely monitors the water supply. When it is about used up, he'll flood irrigate one last time, hoping water will soak in and keep the ground moist for the final cutting of hay. "I've never really been caught short," he says, "but 'weekend farmers' who aren't watching can get surprised when everything dries up all of a sudden. For someone like me, it's my livelihood. I can't afford to get caught."

"Last year we ran out of water on August 28. That's about two weeks shy of the usual irrigation season," Doney remembers.



Particularly in dry years, the two ditch riders in the Jocko District tend to take some heat. While Doney in his role as water commissioner doesn't ride ditches and negotiate individual disputes, he acts as "the on-the-ground eyes and ears for the BIA ."

"Last year one of my neighbors called, saying he wasn't getting water in his subdivision," Doney says.

"We talked about how to get it to him. I went up there and cleaned the ditch on some neighboring land, and then left the water running a little longer on my eighty acres upstream. He's been paying for water for years, but now, for the first time he was getting water. He was really tickled. I did that partly as the water commissioner, but mostly to be a good neighbor," Doney says.

As with precious water everywhere, that neighborliness can get strained. Add in the element of tribal ownership, and tensions mount. Currently, lawsuits are pending against the tribes, against the BIA, and against several individuals, including Doney, over water allocation throughout northwest Montana on tribal lands.

"Frankly," says Doney, "there are people who don't like anyone telling them how to use water. Not the feds, and especially not the Indians."

"This has turned into a big court battle. I heard we even made the news in France," Doney laughs.

"Because it is tribal water, this case will go to federal court. It will be thirty years getting worked out. I'll be gone by then. The lawyers working this case will be gone by then. The only people making any money or getting satisfaction are the lawyers. It's ugly, and in the long run, it will hurt us all."

"There's only so much water," Doney sighs, looking out the kitchen window, "and everyone wants a piece of it."

That statement sums things up for all of Montana when it comes to the liquid treasure keeping us alive.

EFFECT OF FREQUENT DROUGHT ON THE AVAILABILITY OF FUTURE WATER SUPPLIES

EFFECTS OF DROUGHT ON FUTURE WATER SUPPLIES

The following information on Montana's surface water resources is summarized from more detailed information provided in the individual basin reports.

The effect of drought on future surface water supplies depends on duration, geographic extent, and the mitigating effects of reservoir and groundwater storage. Droughts vary in duration from one to several years and may be continuous or interrupted by normal or high water years. They may be localized or may affect broad areas. Water supplies in basins with reservoir storage are buffered from the effects of drought, yet even in basins with significant reservoir storage capacity prolonged drought can disrupt water deliveries.

Drought also reduces the quantity of water available to recharge groundwater. This effect lowers the groundwater levels that support base flows in streams and rivers during dry years. Once depleted during an extended drought, groundwater may take years to recover to normal levels. Intact floodplains and healthy riparian areas slow runoff, promote groundwater recharge, and hasten recovery of groundwater storage following drought.

Records from droughts in the 1930s, 1980s, and 2000s provide points of reference of the potential effects of drought on water supplies. In many areas, the drought of the 1930's exceeded the more recent droughts in magnitude and duration. For example, streamflow data from the gaging station on the Madison River near West Yellowstone in Figure 16 illustrates the differences between average monthly flows during the 1930s and 2000s droughts. Overall, the river produced about 15 percent less water,

MADISON RIVER NEAR WEST YELLOWSTONE
COMPARISON OF FLOW DURING 1930s DROUGHT TO RECENT DROUGHT

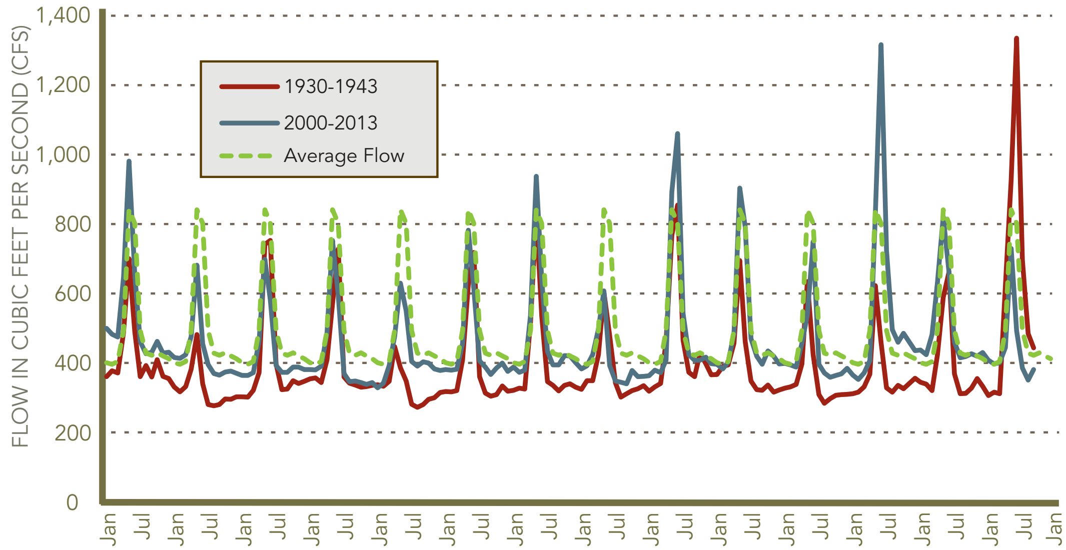


Figure 16: *Comparison of monthly flows for the Madison River near West Yellowstone: Average flow versus droughts of the 1930s and 2000s*

MODELED CANYON FERRY RESERVOIR CONTENTS

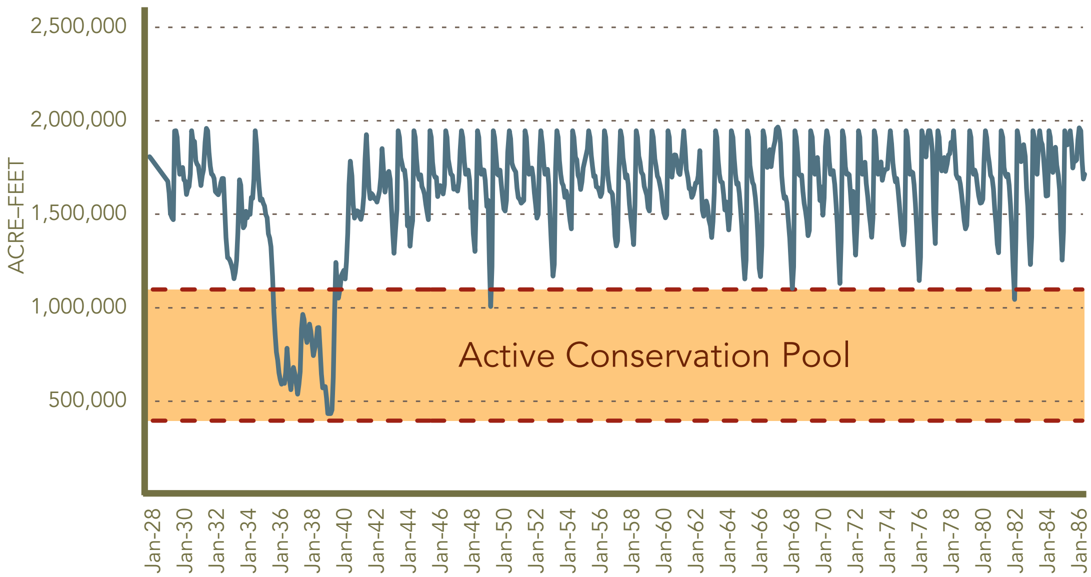


Figure 17: *Modeled Canyon Ferry Reservoir Contents from Dolan and Deluca (1993)*

FRESNO RESERVOIR STORAGE CONTENTS 1980-1989

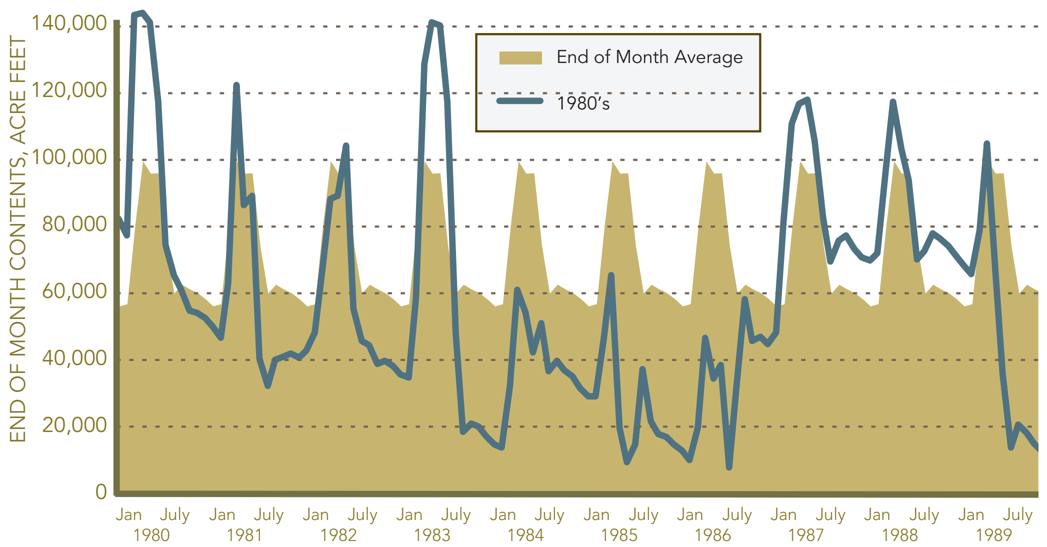


Figure 18: *Fresno Reservoir stored contents, 1980 through 1989*

HYDROGRAPH FOR WELL (GWIC# 1575) PRECIPITATION DEPARTURE FROM ROUNDUP

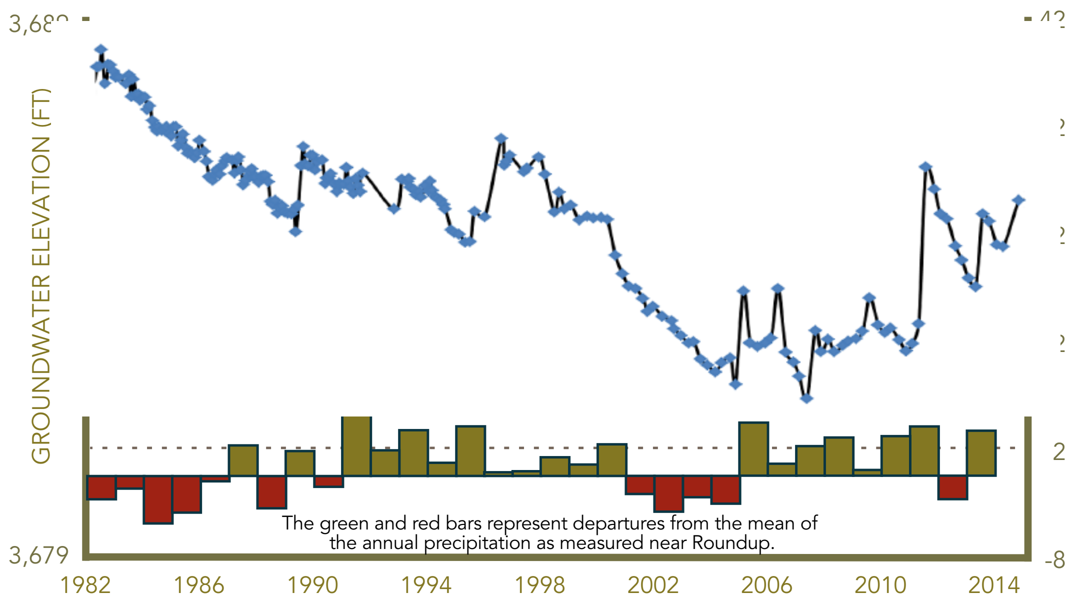


Figure 19: *Groundwater levels in a well near Roundup showing the effect of the 2000s drought*

with greater impacts to base flows, during the 1930s than it did during the more recent drought.

Reservoir storage can mitigate the effects of drought, but even large reservoirs cannot fully compensate for a prolonged, severe drought. As an example, consider Canyon Ferry Reservoir, which was not completed until 1954. Computer modeling can simulate how the reservoir might have performed had it been in place during the 1930s drought. Figure 17 is a graph of simulated Canyon Ferry Reservoir contents for the 1928-1985 period based on the DNRC Missouri Basin Model developed in 1993 (Dolan and Deluca, 1993). The simulation shows reservoir contents dropping to near the bottom of the active reservoir conservation pool during the drought. Under this simulation, the reservoir was modeled to attempt to maintain current levels of downstream hydroelectric production. It is possible, or perhaps even probable, that U.S. Bureau of Reclamation would modify its operations of the reservoir under these extreme circumstances to avoid such a low reservoir drawdown. Still, the simulation demonstrates that a prolonged drought of this magnitude would stretch the limits of the carry-over storage of even the largest reservoirs in the state.

The ability of the smaller reservoirs to meet demands likely would be even more constrained than Canyon Ferry. Figure 18 shows the monthly storage record for Fresno Reservoir for the 1980's compared to the historic average storage pattern. Storage deficits can be seen in the early 1980's mainly during August through February and worsening in the mid 1980's as the drought progressed.

Groundwater sensitivity to drought varies with the ability of an aquifer to transmit and store water, proximity to recharge sources such as surface water, and depth. Figure 19 is a graph of groundwater levels in a monitoring well (GWIC # 1575) in the Fort Union Formation near Roundup shows water levels falling approximately 6 feet from 1981 to 2006 and rising 4 feet following the 2000s drought. The Fort Union Formation is an important source of springs that ranchers depend on for watering stock. Declining groundwater levels can reduce flows from these springs and force ranchers to find other sources of stock water. Declining groundwater levels also result in reduced base flow to rivers and streams which will further reduce the amount of water available to meet competing demands.

Extended periods of drought have the potential to impact every sector of Montana's economy. Given today's higher demands for water, a prolonged drought like the one that Montana experienced in the 1930's and 1980's will likely create a hardship for every water use sector in the state. Agricultural production will likely decline as there is less water available to support a larger irrigation base. Dry land farmers will also suffer from reduced rainfall. Lower river flows will reduce the output from Montana's hydroelectric dams. Low flows and higher water temperatures will stress our aquatic environment impacting Montana's ability to enjoy fishing and recreating on the state's rivers and lakes.

EFFECTS OF CLIMATE TRENDS ON FUTURE WATER SUPPLIES

To forecast the effect of climate trends on future water supplies in Montana, DNRC developed a range of climate scenarios following general procedures similar to those described in the U.S. Bureau of Reclamation (2011) West-Wide Climate Risk Assessments. Virtually all model simulations project warmer temperatures and most project modest precipitation increases. As a result of these trends, annual stream flow volumes are expected to stay the same or increase depending on the basin and model scenario, with shifts in streamflow timing (Figures 20 through 23). The timing shifts would be due to an earlier snowmelt and an increase in the rain fraction of the precipitation during the later winter and early spring. Earlier runoff is projected with December through March showing an increasing trend while late season runoff (July through November) shows a decreasing trend. The earlier shift in runoff timing is more predominant for the warmer scenario groupings. Changes in timing may have lesser effects on water use in basins with reservoirs that store spring snowmelt, which

UPPER MISSOURI RIVER BASIN MODELED MEDIAN MONTHLY FLOW

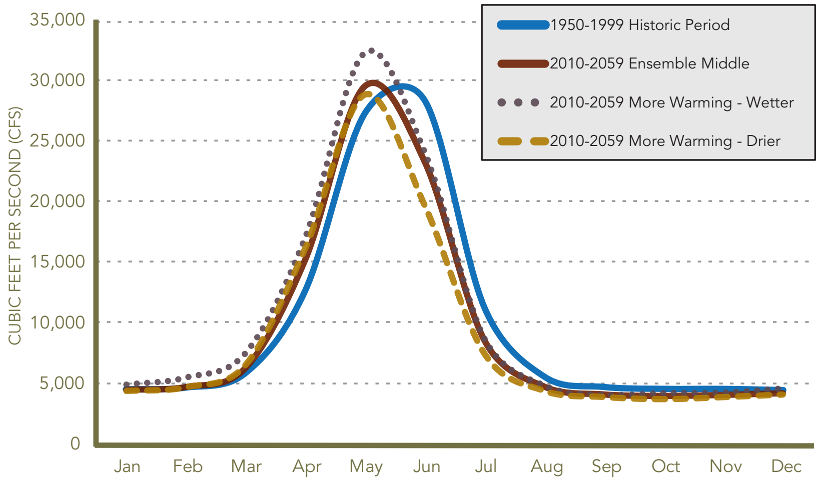


Figure 20: *Modeled median monthly flow for the Missouri near Virgelle under historic conditions and future climate scenarios*

CLARK FORK RIVER BASIN MODELED MEDIAN MONTHLY FLOW

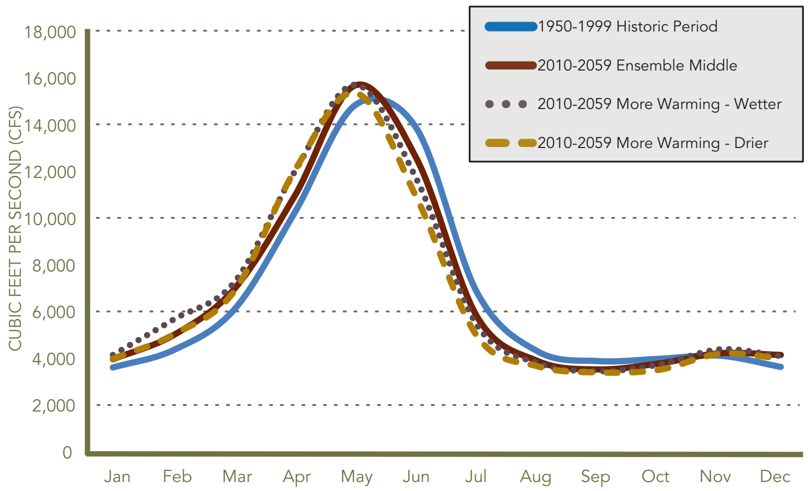


Figure 21: *Modeled median monthly flow for the Clark Fork River below Missoula under historic conditions and future climate scenarios*

can then be released for summer irrigation. Yet reservoirs may take longer to fill, and the timing of releases may need to change to reflect reduced snowmelt and an increase in the portion of precipitation that occurs as rain.

MUSSELSHELL RIVER AT FORT PECK RESERVOIR MODELED MEDIAN FLOW

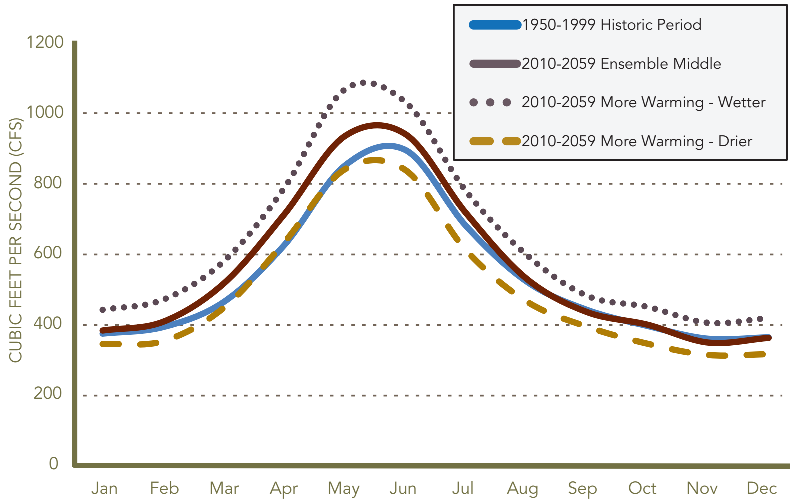


Figure 22: *Modeled median monthly flow for the Musselshell River at Fort Peck Reservoir under historic conditions and future climate scenarios*

YELLOWSTONE RIVER AT BILLINGS MODELED MONTHLY MEDIAN FLOW

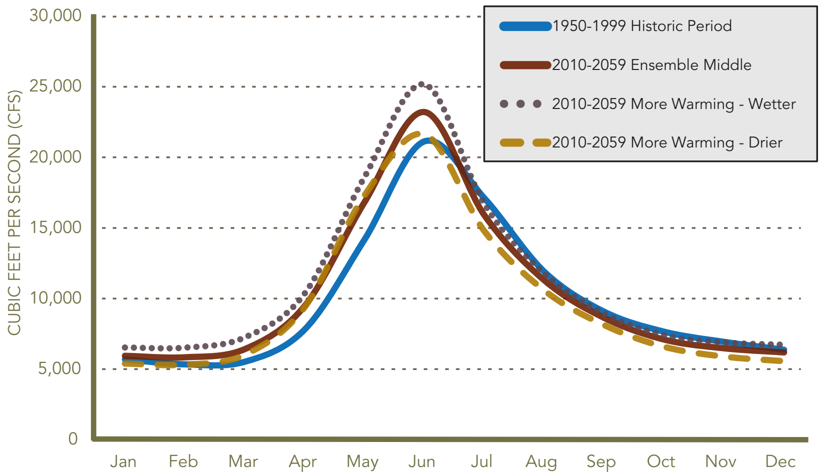


Figure 23: *Modeled median monthly flow for the Yellowstone River at Billings under historic conditions and future climate scenarios*

Messing About in Boats

Snapshot of a Paddler's Life

WRITTEN BY AL KESSELHEIM, PHOTOS BY THOMAS LEE

The modest home of Jim Greene and Martha Vogt is a shrine to their passion. Wooden Grey Owl paddles propped in room corners. Framed quotes from *The Wind In The Willows.* A Carl Wimar print of "Indians Crossing the Upper Missouri". Upstairs, jars with dried beaver scat, raptor pellets, turtle shells, a bag of Goldeneye feathers. The banister on the stairway is a beaver-gnawed branch. Clyde Aspevig's "The Passage" hangs on one wall, a landscape perspective along the wild portion of the Missouri River, near Hole in the Rock.

Out in the garage hang four canoes, each meticulously maintained. Wood gunwales, cane seats, paddles resting across the thwarts, boats for flat-water and rapids, solo and tandem, ready for the next trip, redolent with memories of past ones.

Jim and Martha's second date was in a canoe, when Jim took her out to see a heron rookery on the Clark Fork outside of Missoula. "We got in the boat that day and I saw that she knew how to hold a paddle and take a stroke," Greene remembers. "That made an impression."

Martha grew up paddling rivers and lakes in Michigan, but Jim introduced her to whitewater, and their relationship revolved around time in canoes on the Blackfoot, Clark Fork, and Bitterroot Rivers.

"Canoeing is a metaphor for relationships," Greene says. "The teamwork, the communication, knowledge of your partner."

"That teamwork is a beautiful thing," adds Vogt. "When you make a sweet eddy turn together, or come in to shore just right, or work together setting up camp.

"It can go the other way, too. If we're not in a good space together emotionally, it doesn't tend to go well!"

"Whenever life is hard," adds Greene, "we tell each other to 'keep the paddles in the water'."

In 1995, the couple took a long trip through the Wild and Scenic section of the Missouri River together, and fell in love with the landscape. They took along James Willard Schultz's Floating on the Missouri, a classic account of a late fall trip Schultz took with his Indian wife in 1901. Vogt and Greene read sections of the book to each other as they paddled down the same stretches.

"Every time back we see new things," says Greene. "The weather is always different, and we notice things we haven't seen before."

Greene and Vogt work as seasonal BLM campground and river launch hosts along the Missouri, based at Coal Banks Landing or Judith Crossing. They also survey and study the campsites along the river to record camper impacts on the landscape.

"We keep finding reasons to go back," Vogt laughs. "We cover historic sites, too."

"We like to give back to the river because it has given us so much," adds Greene. "When I check someone in at the river launch, I always tell them to take their time. I even discourage them from taking books to read because it distracts from the experience of being there."

For Jim and Martha, part of giving back to the Missouri involves serving on the board of the Friends of the Missouri Breaks National Monument, working with BLM state archaeologist, Zane Fulbright, and taking part in Lewis and Clark activities.

Vogt and Greene cherish the Missouri for its unchanged scenery, and for the sense of all the history that has taken place there.

"Whenever life is hard we tell each other to 'keep the paddles in the water.'"

—Jim Greene

"Last year we were on Cow Island on September 23rd, the same day the Nez Perce crossed on their flight toward Canada in 1877. I remember we ran aground in some shallows and I thought, that's why they crossed here," says Greene.

"We like to think about Lewis and Clark pulling up the river, fifteen miles a day. They were tougher in those days," says Greene. "What they did was truly incredible."

"I'm actually even more drawn to the Indian sites," says Vogt. "When you find teepee rings it's always a perfect spot, with a breeze to keep the bugs down, the best views to see things coming."

"It makes me think of that Charlie Russell painting about the Indians discovering Lewis and Clark," says Greene. "Russell was really good at providing perspective on the social context as well as the landscape."

When Vogt and Greene climb into the canoe together, Vogt takes the stern and Greene mans the bow. "Most times we've gotten in trouble in the canoe, we've been switched. Now, if things look dicey, we always change back to our preferred positions."

They have paddled together so long, over so many miles, that very little needs to be said. Mile after mile, strokes in synch, the wide sky overhead and the cliffs and coulees beckoning. Along the way they stop and explore, walking up draws, checking out old buildings, noticing birds and wildlife, finding nature's tidbits.

In Schultz's book, his Indian wife talks about the water spirits in the big, swirling eddies. "I always make a point of saying hello to those spirits," says Vogt.

In a framed quote from Kenneth Grahame's The Wind in the Willows next to the front door of their home, Vogt and Greene sum things up.

"The river . . . . What it hasn't got is not worth having, and what it doesn't know is not worth knowing."

All this partnership needs is a canoe to set in the water. ■

POTENTIAL FUTURE DEMANDS FOR WATER IN MONTANA

The following information on Montana's surface water resources is summarized from more detailed information provided in the individual basin reports.

The primary purpose of water resource planning is to examine the variables that may affect future supply and demand, and to develop strategies and tools for meeting demands while protecting existing beneficial uses. Demand for water is a function of many factors that are inherently uncertain. Population may grow or decline and agriculture and industry may demand more water or make do with less through greater efficiency. Changing and variable climatic conditions compound this uncertainty. DNRC considered these and other variables in developing the following projections, but bear in mind that they are just that: projections. They do not account for large shifts in population or agricultural water use, or the emergence of a water-intensive industry.

AGRICULTURAL DEMAND PROJECTIONS

Agricultural irrigation is the largest consumer of water in Montana; consequently, any change in irrigation demand has the largest potential to impact water supplies. Changes in the demand for irrigation water over the next two decades are most likely to arise from acreage being added or removed from irrigation service. While the feasibility of developing irrigation on previously non-irrigated acreage may be low, the potential for expanded irrigation is possible. On the other hand, agricultural land in some parts of the state may convert to residential and municipal use, possibly shifting demand for water and affecting return flows and aquifer recharge.

DNRC considered two scenarios for irrigation development on lands identified through the water reservation process conducted in the late 1970's and early 1990's in the Missouri and Yellowstone basins. One scenario is based on the projection of historical development trends and the other scenario is based on full development of the reservations.

The water reservation processes in the Missouri and Yellowstone basins included substantial efforts to identify potential irrigation projects that were vetted based on project feasibility and were considered to be the most likely lands for future expansion of irrigation. Volumes of water granted through reservations totaled: 548,186 acre-feet with a priority date of 1979 in the Yellowstone Basin; 256,994 acre-feet for the Lower Missouri Basin and 51,579 acre-feet in the Upper Missouri Basin with a priority date of 1985. Overall, reservations for nearly 857,000 acre-feet were granted to conservation districts in the three basins.

As of 2013, 128,000 acre-feet (15 percent of the volume) of the water reserved for irrigation in those three basins was put to use. Extrapolating the allocation trends for each conservation district through 2035 would result in an additional 106,000 acre-feet diverted to serve 57,000 new acres under irrigation, consuming an additional 85,000 acre-feet (Table 4). Demand for irrigation water may increase in particular locations of the Clark Fork and Kootenai Basins, but recent trends suggest that appreciable expansion of irrigated acres is unlikely west of the Continental Divide.

Table 4: *Projected new irrigated acreage and agricultural demand for CD water reservations (2035)*

Planning Basin	Acres	Withdrawal (AF)	Consumption (AF)
Clark Fork / Kootenai*	0	0	0
Yellowstone	36,652	68,723	54,978
Lower Missouri	17,614	33,027	26,422
Upper Missouri	2,299	4,311	3,449
Total	**56,565**	**106,061**	**84,849**

** There are no water reservations in the Clark Fork or Kootenai basins*

Full development of conservation district reservations on all lands identified through the reservation process would result in approximately an additional 654,000 acre-feet of water diverted to serve 349,000 new acres under irrigation, consuming an additional 523,000 acre-feet (Table 5). The reservation process assumed new irrigation projects would be served by center pivots and assumed the projects would have zero conveyance loss. Consequently, the estimates in Tables 4 and 5 include a much higher overall efficiency than the statewide average of less than 30 percent. The projected amount of water diverted under the full development scenario is less than the 857,000 acre-feet reserved because of acreage limitations in the reservations and the assumed high level of project efficiency.

Any hypothetical decline in irrigation demand on acreage that is displaced by municipal and residential development would be offset to some degree by the increase in demand for water for those new uses. More importantly, any water not diverted for irrigation of displaced lands would likely be diverted by other irrigators in water-short basins and would result in no decline in irrigation demand and potentially an overall increase in consumption.

There are many potential effects of a changing climate on irrigated agriculture in Montana. Evapotranspiration, the consumption of water by plants, on current irrigated acreage is expected to increase if warmer conditions prevail in the future. The upper range of the projected increase in evapotranspiration is 2.6 inches (16 percent), and the median increase is 0.5 inch (3.1 percent). Applied to the scenarios of increased irrigated acreage, increased evapotranspiration could result in additional demands for irrigation ranging from a slight increase of 3,500 acre-feet under the base acreage scenario and median increase in evapotranspiration to an increase of 113,000 acre-feet under full development of the water reservations and the maximum modeled increase in evapotranspiration.

MUNICIPAL, DOMESTIC, INDUSTRIAL, AND INSTREAM FLOW DEMAND PROJECTIONS

Montana's population is likely to continue growing along with demand for water to meet municipal and domestic purposes. If statewide population continues to grow at the same rate as seen from 1990 to 2010 (based on census data), Montana will have 302,923 additional residents by 2035 and a total population of 2 million by 2077. (Computer modeling by the Montana Department of Commerce projects statewide population growth rates of about half those based on census data.)

More than 80 percent of the projected growth is expected to occur in the watersheds associated with Billings, Missoula, Kalispell, Bozeman, Butte-Silver Bow, Helena, and Great Falls. In roughly half the watersheds in the state, population would be stable or decline.

Table 5: *New irrigated acreage at full build out of conservation district water reservations*

Planning Basin	Acres	Withdrawal (AF)	Consumption (AF)
Clark Fork / Kootenai*	0	0	0
Yellowstone	254,537	477,256	381,805
Lower Missouri	75,428	141,428	113,143
Upper Missouri	18,675	35,015	28,012
Total	**348,640**	**653,999**	**522,960**

** There are no water reservations in the Clark Fork or Kootenai basins*

Future demands on municipal water supplies will be concentrated in the high-growth watersheds, but water use is also expected to increase in areas not served by public water supplies.

If the population growth rates based on census data continue, DNRC estimates that by 2035 demand for public water supplies and self-supplied domestic water will increase by 73,499 acre-feet, with 28,792 acre-feet consumed statewide over current withdrawal of 198,000 acre-feet and consumption of 86,000 acre-feet (Table 6).

Municipal water suppliers may need to increase their delivery capacity and new public water supply systems may be constructed. Unless laws change regarding exempt wells, the proliferation of self-supplied domestic wells will likely continue as rural populations expand, primarily in the state's western valleys.

Water demands for construction and other urban industrial water uses generally are expected to grow in proportion to population and are reflected in projections of future water demands for public water supplies. Other industrial uses, such as fracking for oil and gas extraction, potential coal-to-liquid (CTL) fuel facilities, and mining, are not served by public water supplies and do not follow predictable trends.

Demand for instream flow and recreation takes many forms including flat water and stream fisheries, aquatic habitat including wetlands, boating and wildlife. Population growth, demographic trends, trends in hunting and fishing license sales, and the potential for endangered species listing all may affect the magnitude and regional pattern of demand for instream flows.

Table 6: *Projected increases in withdrawal and consumption for domestic use in 2035*

Planning Basin	Public Water Supply (AF)		Self-Supplied Domestic (AF)	
	Withdrawals	Consumption	Withdrawals	Consumption
Clark Fork / Kootenai	27,756	10,270	6,257	3,129
Yellowstone	12,323	4,559	1,749	875
Lower Missouri	368	136	69	34
Upper Missouri	20,774	7,686	4,204	2,102
Total	**61,221**	**22,651**	**12,279**	**6,140**

OPTIONS FOR MEETING FUTURE WATER DEMANDS

OPPORTUNITIES, STRATEGIES, AND TOOLS

Unallocated Water

The following information on sources of water that may be available for new appropriations is summarized from more detailed information provided in individual basin reports. Overall, the availability of water for new appropriations varies across the state and is subject to both physical water availability and existing legal demands (Table 7 and Figure 24). Many of the basins located in the western third of the state are generally closed to new surface water appropriations. Exceptions may be available for various consumptive and non-consumptive uses depending upon the closure. Applications for new groundwater uses are not prohibited in closed basins, but they generally require reallocating water from an existing surface water or groundwater use through a mitigation or aquifer recharge plan. Options have increased in recent years to facilitate mitigation and mitigation banking as explained below.

Opportunities for new appropriations for surface water or hydraulically connected groundwater may also be limited outside closed basins because of irrigation claims, hydroelectric rights, or instream water rights for fisheries, wildlife, and recreation. Exceptions include the Yellowstone River downstream of the Bighorn River, the Missouri River downstream of Morony Dam, the Kootenai River, and intermittent and ephemeral drainages in eastern Montana. Surface water is available seasonally or on limited reaches of other streams. The potential for new appropriations of groundwater from aquifers that are hydraulically connected to surface water is typically limited by the legal availability of flows in the connected surface water source.

CHANGES IN USE – REALLOCATION OF WATER FOR NEW USES

The place of use, point of diversion, purpose of use, and place of storage are all elements of an existing water right that may be changed upon proof that the proposed change will not cause adverse effect to other water users. The Water Use Act also includes special provisions for changes for aquifer recharge and mitigation, temporary changes, and temporary leases. These provisions provide water marketing opportunities along with the ability to

Table 7: *General availability of surface water and connected groundwater for new appropriation*

Basin	Limitations on New Appropriations
Clark Fork / Kootenai	Basin closures in the Bitterroot, Upper Clark Fork, and several smaller sub-basins limit appropriations to surface water exceptions and groundwater subject to 85-2-360, MCA. Hydroelectric rights at Noxon and Kerr dams limit new appropriations; instream flow rights for fisheries and recreation limit new appropriations in the Bitterroot, Rock Creek, Blackfoot, Middle Fork and North Fork Flathead, Tobacco, and several smaller tributaries
Lower Missouri	Basin closures on the Milk and its southern tributaries, and the Musselshell limit appropriations to groundwater subject to 85-2-360, MCA and surface water for small domestic and stock uses (southern tributaries). Compact closures limit appropriations on Big Sandy Creek, Beaver Creek, Sage Creek, Cut Bank Creek, Frenchman Creek, Poplar River, Porcupine Creek, Rock Creek Whitewater Creek, Big Muddy Creek, Milk River, and tributaries to Fort Peck Reservoir. Irrigation diversions limit new appropriations on the specific reaches of the Judith River, Big Spring Creek, Warm Spring Creek, Arrow Creek, and Flatwillow Creek. New appropriations are possible on intermittent and ephemeral tributaries, the Missouri River, and Fort Peck Reservoir.
Upper Missouri	Basin closures on the Missouri and its tributaries including the Teton, Sun, Smith, Jefferson, Madison, Gallatin, Boulder, Beaverhead, Big Hole, Ruby and Red Rock rivers limit appropriations to exceptions including groundwater subject to 85-2-360, MCA. Hydroelectric rights at Great Falls and throughout the Upper Missouri limit new appropriations of all types. New appropriations are possible from the Marias during early irrigation season. Lower Marias flows are regulated by Tiber for instream flows and existing diversions.
Yellowstone	A basin closure on Rock Creek for the irrigation season limit appropriations of surface water to exceptions including groundwater subject to 85-2-360, MCA. Compact closures limit appropriations in the Bighorn, Little Bighorn, Pryor and Rosebud sub-basins. Water may be available from conservation district reservations downstream of the mouth of the Bighorn River. No permits have been issued on the Powder, Tongue, and Big Porcupine since 1995. New appropriations may be available from the Yellowstone above Billings. New appropriations may be possible at selected times including during high spring flows on the Shields River.

STATEWIDE BASIN CLOSURES

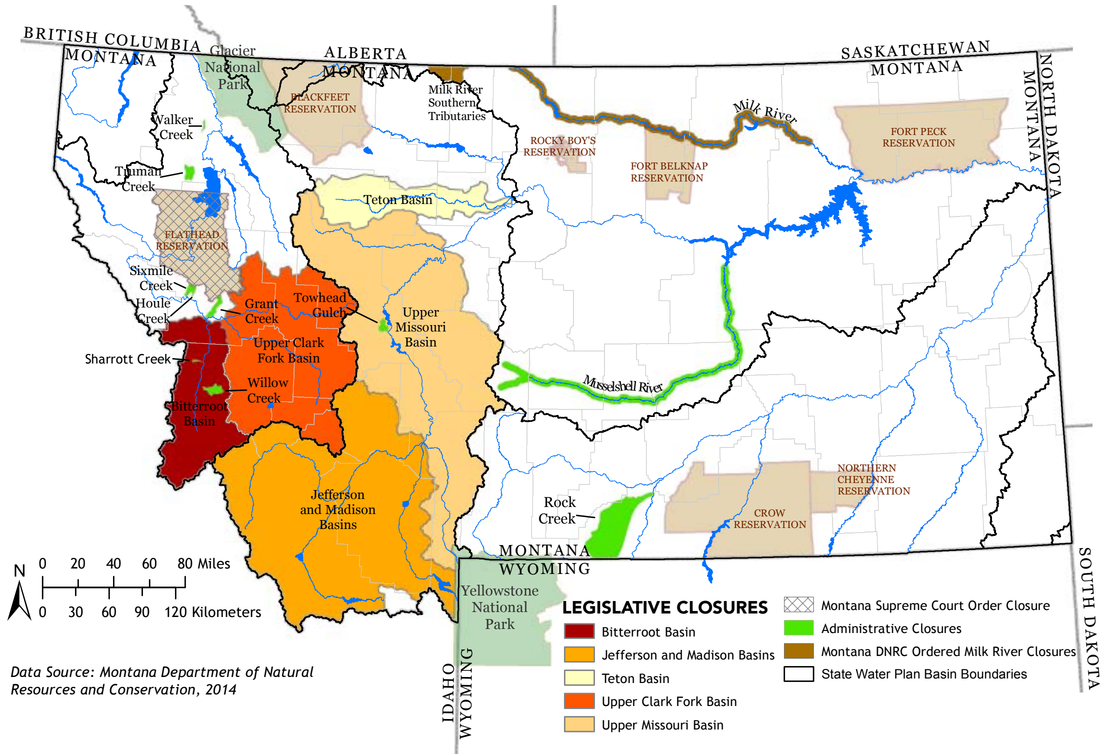


Figure 24: *Statewide Basin Closures*

permanently or temporarily reallocate water for future needs.

Water Use Changes

Under a change authorization a water user may permanently reallocate water to a new purpose while preserving the priority date for the underlying water right. Because a change is doing something new on a source and other water rights exist on that source, a change in use is limited to the historic period of diversion, historic diverted volume, and historic consumptive use (collectively referred to as historic use). These limitations are important to ensure that a proposed change will not adversely affect other water users on the source. Increases in the amount of consumption or changes in the pattern of use from the historic use of the water right can affect other water right holders who depend on that historic pattern of use and amount in making their own use of water. One person's return flow may be another's water supply. Therefore, the historic use analysis also looks at the timing and location of return flows.

Over the past 40 years, the DNRC has developed an extensive set of data, policies, and rules to assist water users in identifying relevant evidence to establish the parameters of historic use. However, potential adverse effects to other water users is often a limiting factor in the ability to change a water right.

A traditional change is an effective means of permanently reallocating water to a new use. Permanent changes also provide a means for mitigating new groundwater uses that deplete surface water and potentially cause adverse effect on over appropriated surface water sources and in closed basins. Changes for mitigation require identification of the specific water right for which mitigation is being provided. The applicant is typically required to demonstrate that the water right being changed will provide sufficient water in timing, location and amount to mitigate potential adverse effect either by leaving the water instream or through use of aquifer recharge.

Mitigation and Aquifer Recharge

In 2011, the Montana Legislature adopted an innovative approach to facilitate the reallocation of existing water rights for the purpose of mitigation or aquifer recharge to allow new uses of water in water short areas. Water for mitigation or aquifer recharge is used to offset depletions to surface water sources from new groundwater wells. Unlike the traditional change process discussed above, the new approach enables a water user to prospectively change all or a portion of a water right to mitigation and have that mitigation water available for lease or sale to applicants seeking new water rights from the DNRC. This process is similar to a water bank for mitigation uses. This new statutory tool provides greater predictability for new water users who need to mitigate depletions from a proposed use and provides existing water users with the opportunity to market water while preserving their existing use. More research is needed in the area of aquifer recharge as a tool for the mitigation of new withdrawals.

Temporary Changes

A water user may temporarily change a water right with DNRC approval pursuant to §85-2-407 and 408, MCA. A temporary change may be approved for up to 10 years, with an opportunity to renew for 10 more years, and there is no limit on the number of renewals. The water user must identify the proposed change and how long it will be needed, as well as meet other criteria. If granted, the temporarily changed appropriation has the same priority date as the existing water right. Unlike a permanent change, temporary changes automatically revert to the original use at the expiration of the term. Therefore, they can be an effective method for providing water for temporary or short term needs.

Temporary changes and leases pursuant to §85-2-408 and 436, MCA, provide the only means for a private water user to maintain or enhance instream flows to benefit the fishery resource. Under §85-2-436 MCA, FWP can change or lease an existing diversionary right to an instream-flow use to benefit the fishery resource consistent with the requirements of §85-2-408 MCA. Section 436 also provides FWP with the authority to make a permanent conversion of a diversionary water right to instream flow on no more than 12 stream reaches.

Temporary Leases

In 2013, the Montana Legislature adopted §85-2-427, MCA, which provides the opportunity to lease a water right for 2 years within a 10 year period. While the volume of water that may be leased is limited to 180 acre-feet per year, the statute provides a simplified and faster procedure. This new statutory tool enables water to be temporarily reallocated to serve short term needs and provides existing water users with the opportunity to market water while preserving their existing use.

Salvage Water

Pursuant to §85-2-419, MCA, a water user may retain the right to the beneficial use of water "salvaged" by implementing a water-saving method. However, the right to the use of salvage water for any purpose or in any place other than that associated with the original water right requires prior authorization by the DNRC and is subject to the change provisions of §85-2-402, MCA. In practice, water users have had limited success in proving the existence of salvaged water and lack of adverse effect to other water users due to the fact that many efficiency improvements result in increased consumption or otherwise alter conditions on the source relied upon by other water users.

Voluntary Water Management

Locally initiated water management plans are also an effective tool for stretching Montana's water supplies during times of shortages. All of these efforts are highlighted by some common elements: voluntary cooperation from a wide range of stakeholders, local solutions to fit local needs, joint sacrifices and sharing of shortages. The tension that develops between irrigated agricultural interests and advocates for instream flow during times of shortages is typically the genesis for the development of these plans. Although the parties may have competing water use interests, they are united in their desire to improve water management for the benefit of their local communities. The success of these water management plans is

dependent on strong local leadership, access to timely and relevant information to support decision making, and a willingness on the part of all parties to support the plan within the prior appropriation framework. Technical support from state and federal natural resource agencies is also a critical component of successful local planning efforts. Examples of successful locally developed water management plans and can be found in watersheds across Montana.

OPPORTUNITIES FOR RESEARCH AND INVESTMENT

The reallocation of existing water rights to new uses will require (1) improved methods for calculating historical consumptive use and (2) expanded stream gaging to measure the available supply and evaluate physical and legal availability of water for appropriation.

DNRC calculates historical consumption associated with pre-1973 water right claims from various sources of information. Historically irrigated acres are derived from water resource survey maps, historical aerial photography, and affidavits from water users. Consumptive water use is then calculated by applying standard engineering equations on crop water demands to county level agricultural statistics. Given the site specific nature of irrigation practices and crop water needs, the use of county level agricultural data may over estimate consumption in some cases and under estimate consumption in others.

More accurate methods of determining consumptive use are needed as competition increases for limited water supplies and the knowledge of irrigation practices used prior to 1973 fades with time. Advances in the development of computer modeling software to calculate water consumed by crops using commercially available information generated from NASA's Landsat Program provide an opportunity for Montana to bring a higher degree of accuracy to the water right change process.

OPPORTUNITIES FOR STORING SPRING RUNOFF

Basins with Hydrology that Could Potentially Support New Storage

The hydrology of streams in Montana, particularly in mountainous areas, might be suitable for new reservoir storage because much of the annual flow volume in Montana is produced during the relatively short spring-runoff period. Water is potentially available for storage during runoff when water supply conditions meet or exceed median conditions and where existing storage capacity is small relative to the total volumes of water produced annually in the watershed. As an illustration, Figure 25 depicts median daily flows for the Missouri River near Toston, including simplified delineations of when water might be stored and again released to ease shortages. Canyon Ferry Reservoir, downstream of Toston, regulates the flow of the Missouri River and at least partially stores, and releases water similar to this illustration.

In the Upper Missouri planning basin, existing reservoirs in the Marias, Teton, Sun, and Beaverhead basins store relatively large volumes of water when compared to the amount of water produced annually in these watersheds and, therefore may not be attractive locations for additional storage from a hydrologic standpoint. In comparison, the Gallatin and Big Hole watersheds may be more attractive from a hydrologic standpoint because the existing storage capacity is small compared to the total flow produced.

In the Clark Fork and Kootenai Basins the existing storage capacities are small compared to the total flow produced. Exceptions are the Flathead and

MISSOURI RIVER AT TOSTON MEDIAN DAILY FLOW

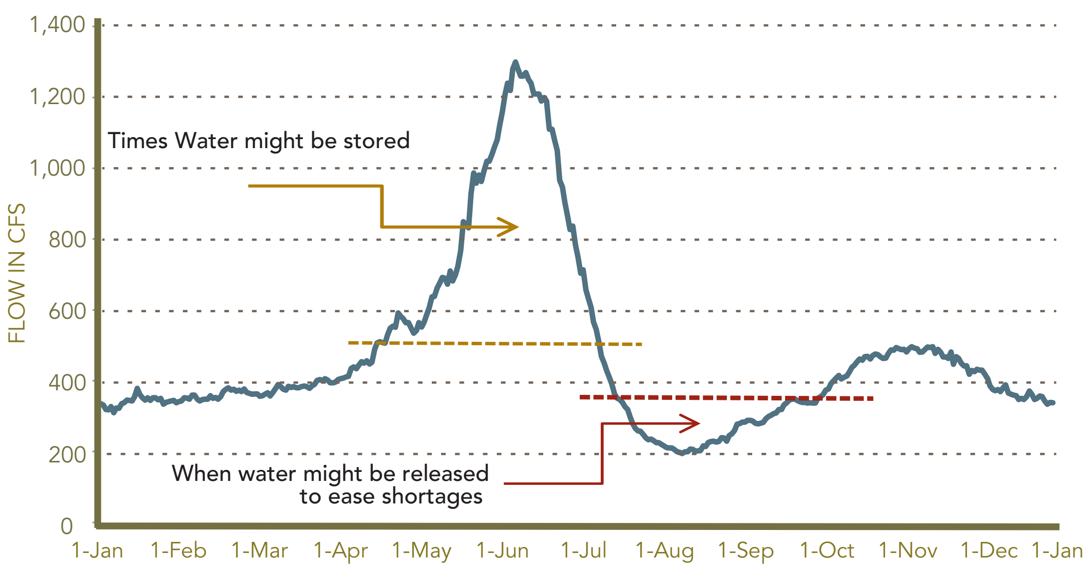


Figure 25: *Median daily flow of the Missouri River at Toston depicting times of potential storage and releases*

Kootenai Rivers. The strongest demand for new or additional storage will likely be heard in the Upper Clark Fork, Bitterroot, and Blackfoot River watersheds, where demand for water is high and the water supply conditions are some of the lowest in the basin. These basins store less than 10% of the total flow. Water is potentially available for storage during runoff when water supply conditions meet or exceed median conditions.

Most eastern Montana prairie streams do not produce large water yields and are therefore not good candidates for traditional water storage. Exceptions exist, based solely upon hydrologic characteristics, on some streams draining snowpack from island mountain ranges of central Montana. Horse Creek and Flatwillow Creek are two streams in the Musselshell Basin that have been studied for potential future storage projects to provide late-season water for irrigation.

The Judith River is another stream exhibiting flow patterns that might accommodate additional storage (Figure 26). High flows arising from the melting snowpack typically peak in late May, before there is demand for irrigation water. The river recedes rapidly after the peak, leaving only 5,800 acre feet of water stored in the watershed, at Ackley Lake.

Several storage alternatives were explored by the USBR on small streams arising in the Little Rocky and Bears Paw Mountains. Analysis determined that although storage projects were technically feasible on a hydrologic basis, they failed on the basis of economics.

Options for storage on the main stem of the Yellowstone River are limited by the lack of suitable dam sites and environmental concerns. The potential for storage on the Wyoming tributaries, Clarks Fork of the Yellowstone, Big Horn, Tongue and Powder River basins is limited by the lack of suitable dam sites, environmental concerns, and physical availability of water to store. The Yellowstone Water Reservations do provide water rights for three off-stream storage projects located mid-basin and north of the Yellowstone River. A 1983 U.S. Bureau of Reclamation preliminary report estimated the following firm-yields (i.e. the amount delivered every year) for the three projects: Buffalo Creek Reservoir (near Bighorn confluence with main stem) could provide 24,000 acre-feet; Starved-to-Death Creek Reservoir (north east of Forsyth) could provide 29,000 acre- feet; and Sunday Creek Reservoir (north of Miles City) 189,000 acre-feet—the latter project would involve importing water from the lower Missouri basin.

Water might be available to store in a basin during the wettest years or even moderately wet years; however, a new reservoir might not be viable if it is not able to store water during a sequence of dry years. Furthermore, storage water rights for existing reservoirs may impose a potentially significant constraint on the feasibility of new traditional storage. Streams where high spring flow could be considered available based on stream flow and local water rights, might affect the ability of downstream reservoirs to store water. For example, new storage development upstream of Canyon Ferry could encroach on Reclamation's senior storage rights unless Reclamation is able to accommodate that new storage through contractual arrangements for Canyon Ferry exchange water.

Another alternative might be to enlarge an existing storage facility to accommodate a greater volume of water. Many facilities may have been potentially undersized when constructed, and based on the hydrology of their basins could store additional water if structural capacity was increased. Fresno Dam on the Milk River has been investigated for storage capacity enlargement.

JUDITH RIVER NEAR MOUTH MEDIAN DAILY FLOW

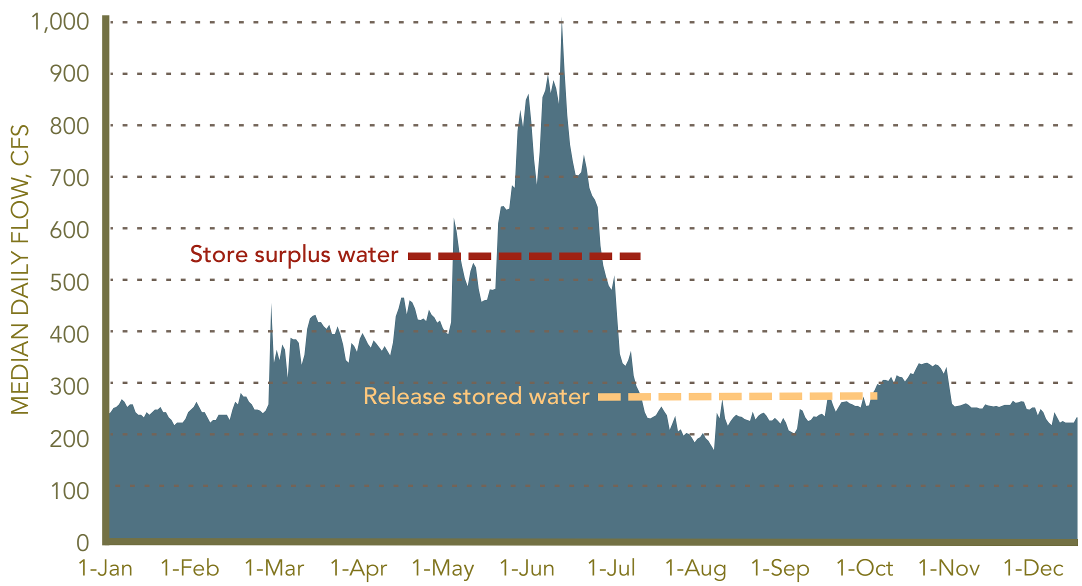


Figure 26: *Median daily flow near the mouth of the Judith River depicting times of potential storage and releases*

FEASIBILITY AND CONSTRAINTS ON NATURAL STORAGE & RETENTION

Floodplains with healthy riparian areas act to slow runoff and promote groundwater recharge; effectively storing water and releasing it slowly back to the surface water system. In this way, these natural systems fill a role similar to traditional reservoirs. The natural storage and retention benefits of these systems can be maintained and potentially enhanced by limiting the encroachment of urban development and impervious surfaces, controlling storm water discharge, protecting vegetation from overgrazing, minimizing stream incision and channelization, and preventing erosion through good forest and range management practices.

Artificial recharge of alluvial aquifers and floodplains may provide additional opportunities to store water when the physical supply exceeds legal demands. The groundwater flow systems in nearly all of the watersheds of western Montana and the large watersheds of eastern Montana have been substantially altered by recharge from irrigation canals and the practice of flood irrigation. Significant volumes of water from irrigation conveyance and application practices are stored in alluvial aquifers and released naturally to support late season streamflows. Water users in these watersheds have grown dependent on these late season return flows. However, aquifer recharge is a consequence of the primary beneficial use of the water.

Existing irrigation infrastructure provides ready means for augmenting the recharge of shallow groundwater systems. In some areas it may be feasible to run water through these systems outside of the normal irrigation season for the purpose of recharging shallow groundwater aquifers. This activity would require a change authorization from DNRC to ensure other water users are not adversely affected.

There may also be opportunities to take advantage of the natural storage potential of shallow aquifers by diverting unallocated flows into constructed wetlands or retention basins. The feasibility of an artificial recharge project will depend on a number of factors including, but not limited to, site specific geologic conditions, and the physical and legal availability of surface water to divert and store.

VIRGELLE FERRY

Portal Through Time and the Elements

WRITTEN BY AL KESSELHEIM, PHOTOS BY THOMAS LEE

Everyone eventually finds a niche in life. Beverly Terry was born into hers on the banks of the Missouri River.

You can find her by driving miles of gravel road across the tablelands north of Great Falls. The road zigs along section lines, the prairie spreads flat to the sky, except for the dark, distant mountain ranges collecting clouds. Grain bins glint in the sun. Horned larks flurry out of the way. Space and more space. Miles of quiet. The road finally tips down through gravel layers, down to the floodplain of the Missouri River, the green bottoms, the groves of cottonwood, the high scarps of riverbank.

Her house is perched on the edge of the sliding, whispering current, surrounded by a few trees, with quaint yard decorations, some flowers. It is where she has spent her entire life, and where generations of her family have lived, operating the Virgelle Ferry, since 1960.

Pull your car up to the call box, toggle the switch to sound a horn and ring a pager, and in a few minutes Terry will emerge on a four-wheeler, jounce her way down to the metal ferry deck, and usher you aboard. It's the county road job she's held for more than 20 years, since 1992.

Terry grew up on this spot, some 20 miles downstream of the confluence with the Marias River, where Lewis and Clark spent some time fretting about which fork to take in June of 1805. Her family lived in the homestead shack her parents added a third bedroom onto to accommodate their brood of 10. Her mother operated the ferry while her dad worked odd jobs and trapped along the river valley. Later, her folks moved another house onto the location, and in 2004, when the new ferry was delivered, Terry got her present home in the bargain.

"I love the quiet," Terry says. "I wake up every morning at 5:30 and lie there, listening to the birds outside, the breeze in the cottonwoods. It is so peaceful."

During the school year, Terry teaches sixth grade on the Rocky Boy reservation, a 37-mile commute each way, but from Easter through hunting season, in November, you'll find Terry running the ferry, answering that timeless need to get across the river.

Drive up the steep metal ramp onto the steel deck, park in front of the fabric netting at the far end, and Terry introduces you to her specialty, the five-minute conversation. She revs the engine and the boat begins its crawl across the wide flow, running off of a pulley hitched to thick cable. The subtle force of the Missouri powers past, and for the trip, the river dimension takes over – motion, inertia, that sense of coming from somewhere, going somewhere, an endless gathering. It grabs you, leans against you, makes you imagine.

"I meet people from all over the world," Terry says. She is wearing blue river sandals, matching blue beaded earrings. Red hair falls loosely around her face. Her smile is easy and warm. "My daughters used to say that I could get more information about people in five minutes than most people get in a year. You never know who will drive up."

Terry says she averages about 20 vehicles a day, but has logged as many as 89. "Sometimes I'm out here for hours at a stretch in the hot sun. But then, the other day, no one came all day long. That was a first."

She guesses that roughly a third of the traffic is tourists, another third locals, and the final third service vehicles. "People visiting friends, going to church, fixing pipelines, heading for town, delivering packages, out to see the scenery. I've taken livestock, especially on the old, wooden boat. They get spooked by the metal deck, so I don't get many animals anymore."

The former, wood-decked ferry is parked a half mile up the road, in the town site of Virgelle, population 2. Her current boat was delivered in 2004, fabricated in Plains, Montana, labeled Hull no. 2. The spotlights and ramp motors run off of a solar panel mounted on her house. The engine is a 3-cylinder job that Terry says she "has some suggestions about when it comes time for a rebuild."

"Used to be six ferries running along the Missouri," Terry says, "including one a little ways up the Marias. Now there are three."

Terry remembers the antique Ford car group that rode the ferry, motorcycle tours, all manner of farm vehicles. "Once I had a wedding party from Virgelle and the engine overheated halfway across. Didn't know if those guys were going to make the ceremony," she laughs.

"Spring and high water is the most dangerous time," she says. "When there is a lot of debris or ice in the river, I won't run. I wake up at night hearing trees bump along the bottom, and sometimes they go right under the boat. Once we had a tree snag on the ferry and tip it up. We had to chainsaw it off. It was like an iceberg – way more of that tree below the water than you could see. Sometimes the high water gets up past the pulley tower and I have to shut down."

The ferry slides gently into the gravel on the south side of the channel. The car eases down the ramp. A hand waves out the window. Terry notices a red pickup coming down the road. She waits there, anticipating another conversation. Swallows cut through the air overhead. Sandhill cranes call from a nearby field. ■

"Used to be six ferries running along the Missouri including one a little ways up the Marias. Now there are three."

—Beverly Terry

MAJOR FINDINGS AND KEY RECOMMENDATIONS

The complete recommendations for the Montana State Water Plan are set forth below. These recommendations were developed from input provided by four regional watershed basin councils, private individuals, and local, state, tribal, and federal resource managers. These recommendations are intended to guide Montana water policy and management over the near, intermediate, and long term bases. Where appropriate, DNRC has identified the agencies with primary responsibility for plan implementation. If unidentified, the recommendation is intended to offer guid ance to the many private, local, state, federal, and tribal entities involved in water management in Montana.

All recommendations contained in the State Water Plan are subject to the exist ing institutional and legal framework for water use in Montana as provided for by the Montana Constitution, prior appropriation doctrine, and Montana Water Use Act. Full implementation of some recommendations may require the Legislature to amend the Montana Water Use Act.

WATER SUPPLY AND DEMAND

Water supply across Montana is controlled by the variability in seasonal temperature and precipitation. While the demand for water continues to grow, water availability varies from year to year and often changes dramatically within a given year. As a result, coping with supply and demand imbalances is a constant feature of water management in Montana. Ensuring an adequate supply of water to meet current beneficial uses and future demands is a theme echoed by the four Basin Advisory Councils throughout the planning process.

Steps to address these issues include:

Support Water Use Efficiency and Water Conservation

As the demand for water increases, water conservation and water use efficiency to reduce the consumption of water will play a larger role in meeting the state's future needs. Looking ahead, we must focus on innovative strategies to stretch supplies and promote water conservation while protecting against adverse effects to existing water users.

There is a general misunderstanding that when irrigators, municipalities, or other water users improve the efficiency of their water systems so that they divert or discharge less water that they are actually "saving" or reducing water consumption. In reality, irrigation upgrades, for example, may actually increase water consumption through higher crop yields and reduced return flows relied on by other water users. Additional adverse effects may include decreased recharge of shallow groundwater. The Montana Water Use Act prohibits changes in water use that result in adverse effects to other water users on the source. Site-specific investigations, long-term monitoring and development of tools and strategies for mitigating the adverse effects from increasing efficiencies are needed to facilitate informed decisions on new permitting and water right change authorizations.

Free flowing wells are found throughout Montana and are a valuable asset, especially for stock water in remote areas, but left uncontrolled they can waste water and contribute to the decline of groundwater levels. Records from the Montana Groundwater Information Center (GWIC) indicate that there are more than 4,400 wells reported as "flowing" at the time of construction. With an average flow rate (of measured stock wells) of 20 gallons per minute, equipping a single well with a flow control valve can save approximately 32 acre feet per year. Monitoring by Montana Bureau of Mines and Geology indicate that water levels in the Lower Hell Creek – Fox Hills aquifer along the Yellowstone River corridor from Miles City to North Dakota have declined as much as 100 feet over the past 30 to 40 years partly due to uncontrolled flowing wells.

SHORT TERM RECOMMENDATIONS (0-2 YEARS)

- Support both site-specific investigations and long-term monitoring studies to quantify the effects associated with changes in irrigation methodologies and improvements to water distribution systems. These investigations will help to inform the development of water efficiency and conservation strategies that use water more effectively.
- Support state and federal programs that assist landowners with controlling discharge from uncontrolled flowing wells.

INTERMEDIATE TERM RECOMMENDATIONS (4–8 YEARS)

- Support the efforts of State agencies, universities and others to identify and pursue research on innovative water management and conservation strategies that are tailored to local needs and conditions.
- DNRC will analyze the water right implications and lessons learned from the land application of treated municipal wastewater.

LONG TERM RECOMMENDATIONS (6–10 YEARS)

- Support the implementation of water conservation incentives and measures that are adaptable to the needs of local conditions, individual watersheds and municipalities.
- The State of Montana should offer incentives that encourage the development of community wells as an alternative to individual wells for domestic water supplies.

Improve and Expand Efforts to Quantify Surface Water Supplies and Availability

The importance of ensuring an adequate supply of water to meet current beneficial uses and future demands is a theme echoed by the four Basin Advisory Councils throughout the planning process. Water supply across Montana is controlled by variability in seasonal temperature and precipitation as well as long-term climatic trends. While the demand for water continues to grow, physical water availability varies from year-to-year and can often change dramatically between seasons in any given year. As a result, coping with supply and demand imbalances is a constant feature of water management in Montana. While we cannot eliminate all supply and demand imbalances, Montana can improve and expand efforts to gather the best scientific information available to quantify water supplies and availability.

SHORT TERM RECOMMENDATION (0–2 YEARS)

- DNRC will work with local water users and other government agencies to conduct a basin-wide physical water availability and water management assessment in the Upper Missouri Basin. The study will assess and analyze how the basin's existing water and power operations and infrastructure will perform under different water supply scenarios. The study will also analyze the effectiveness of adaptation and mitigation strategies for meeting the challenges of supplying adequate water in the future.

INTERMEDIATE TERM RECOMMENDATIONS (2–6 YEARS)

- Build upon the lessons learned from the Upper Missouri Basin water availability and water management assessment to conduct similar studies in other basins.
- Invest in the capacity to identify and evaluate the opportunities and challenges posed by large scale forces that will influence water supply and demand over the next twenty years. Examples of large scale forces include but are not limited to: energy development, demographic shifts, climate variability, the operation of federal dams and reservoirs within Montana and downstream states, treaties and compacts with neighboring states and Canada, and federal actions related to threatened and endangered species. Review and revise the assessment every 5 years.

Increase Flexibility to Manage Available Water Supplies Through Storage and Rehabilitation of Existing Infrastructure

Water storage is an important part of any integrated water resource management strategy. Water storage creates greater flexibility in managing available supplies to meet the multiple demands of agriculture, municipalities, industry, hydropower, fisheries, recreation and water quality.

The Basin Advisory Councils and the public indicated continued support for Montana's policy to actively pursue water storage projects if water storage is found to be the best solution for meeting growing needs and resolving water management challenges (85-1-703, MCA). However, traditional large-scale storage projects are expensive to plan, construct, operate and maintain. The prospect of constructing new large storage projects in Montana is limited by the availability of suitable locations, cost, public support, the need to mitigate environmental impacts, as well as the limited legal and physical availability of water. Smaller storage projects can improve water availability within the year, but lacking significant carry-over storage, may not be effective tools for mitigating water-supply shortages during an extended drought. Other options to explore include retrofitting current storage infrastructure to increase the amount of water stored and modernizing outlet works to enable more efficient operation.

Another important tool for stored water management is the modification of policies and purposes governing project operations that define how and when water is stored or released, and for what purpose (e.g. irrigation, hydropower, instream flow, recreation).

INTERMEDIATE TERM RECOMMENDATIONS (2–6 YEARS)

- Work with state and federal reservoir operators to evaluate policies and purposes that consider multiple benefits and provide additional water to meet other beneficial uses if water is legally available and without jeopardizing the original authorized use of the reservoir.
- Explore opportunities to increase the storage capacity of existing state and federal reservoirs where feasible and modify infrastructure to enable more efficient operations.
- Explore the opportunities and challenges of securing contract water from federal projects such as Hungry Horse, Canyon Ferry, Tiber, Clark Canyon and Yellowtail Reservoirs to provide water for mitigating the effects of new appropriations.
- Work with the Legislature to make funding available to share in the cost of upgrading and rehabilitating existing water conveyance infrastructure. The state will work with willing stakeholders to develop public-private partnerships and innovative funding strategies for projects that cannot be completed within the state's current funding programs.
- Work with willing stakeholders to identify basins where high spring flows are physically and legally available for storage.

LONG TERM RECOMMENDATION (6 – 10 YEARS)

- Work with the Legislature to make funding available to share in the cost of developing additional water storage infrastructure. The state will work with willing stakeholders to develop public-private partnerships and innovative funding strategies for projects that cannot be completed within the state's current funding programs.

Integrate Natural Storage to Benefit Water Supplies and Ecosystems

Existing natural systems, such as riparian areas, floodplains and wetlands act to slow runoff and promote groundwater recharge; effectively storing water and releasing it slowly back to the surface water system. In this way, these natural systems fill a role similar to traditional reservoirs. The hydrologic characteristics of these natural systems also improve water quality. Artificial recharge of alluvial aquifers and floodplains may also provide additional opportunities to store water when the physical supply exceeds downstream legal demands. Integrating existing natural systems and promoting the protection and restoration of natural systems into Montana's water management practices will support late season flows, help to mitigate the impact of drought cycles, and provide environmental benefits.

SHORT TERM RECOMMENDATIONS (0–2 YEARS)

- DNRC will explore the water right implications of integrating natural storage and artificial aquifer recharge into Montana's water use administration.
- DNRC will work with stakeholders to identify and develop at least one pilot project to quantify the capacity and explore the water right implications of using natural storage to enhance water supplies in smaller watersheds.

INTERMEDIATE TERM RECOMMENDATIONS (2–6 YEARS)

- DNRC will work with stakeholders to investigate the feasibility, cost effectiveness, and water right implications of using the natural storage capacity of wetlands, riparian areas, or floodplains to enhance water management in a smaller watershed.
- DNRC will work with stakeholders and the Montana Bureau of Mines and Geology to investigate the feasibility and potential for using aquifer storage and recovery tools to meet local water needs. The investigation will include the geologic conditions required for aquifer storage and recovery, potential adverse effects to surface water flows, financial feasibility, and water right implications.

Support and Expand Existing Drought Preparedness and Planning Efforts

Drought is part of Montana's natural hydrologic regime. Almost any part of the state can experience drought conditions in any given year. Climatologists can now forecast climate anomalies, such as El Niño, six to nine months in advance of onset. El Niño events have a consistent record of bringing warmer temperatures and below normal precipitation to Montana over the winter months resulting in below average water content of the mountain snowpack, an early spring runoff, and surface water shortages. Accurate forecasting of El Niño and other weather related events can provide up to a year of lead time to assist planning and to develop mitigation strategies.

Drought preparedness requires a collaborative approach within small- to medium-sized watersheds. Working together, water users and water management agencies can develop adaptive management strategies that can yield benefits to water supply, fisheries, and water quality. Adaptive management also requires effective coordination between state and federal agencies responsibile for managing water supply, water quality, fisheries, and drought and water supply forecasting. Successful adaptive management is facilitated by ready access to information about stream flow, water rights, water quality and aquatic habitat.

SHORT TERM RECOMMENDATIONS (0–2 YEARS)

- Support the development of drought management plans in small to medium size watersheds.
- Assess potential threats to the state's water supply and economy resulting from extended periods of drought and increased climate variability by partnering with appropriate state and federal agencies to conduct one climate risk assessment pilot study in one of the four planning basins.

INTERMEDIATE TERM RECOMMENDATIONS (2–6 YEARS)

- Support University and college programs, including the Montana Climate Office, involvement in drought monitoring and forecasting in order to increase the lead-time for Montana water users and managers to prepare for times of water scarcity.
- Build upon the lessons learned from the climate risk assessment pilot study identified above and conduct similar studies in the remaining basins.

WATER USE ADMINISTRATION

Historic beneficial use is the basis, measure and limit of a water right. An accurate understanding of water use is critical to Montana's ability to protect existing water rights while meeting new demands through the water right change process or new appropriations of surface water and groundwater.

The existence of unused and overstated claims in the DNRC water rights database may hinder new development in some basins by making water legally unavailable for use. In some cases a water right may remain unused for a period of time due to economic forces. In other cases an appropriator may have filed a water right, but later abandoned their plans to put the water to a beneficial use. Water right administration needs to reflect actual demands and supply on specific sources.

The role of exempt wells in water allocation has created a level of uncertainty for senior water right holders, the development community and DNRC. Exempt wells are exempt for the water right permitting process and allow for the beneficial use of water without an analysis of adverse effect. DNRC has had two very different definitions of "combined appropriation" related to exempt wells. The role of exempt wells in meeting Montana's water needs will remain unclear until the courts or the legislature provide guidance on the intent of the term "combined appropriation". Enforcement against water use without a water right or permit, water use that exceeds the limits of a water right or permit, or water use outside of priority date is also critical to the orderly management of Montana's water resources.

Steps to address these issues include:

Complete an Accurate and Enforceable Water Rights Adjudication

Adjudication of pre-1973 water rights is critical to Montana's ability to develop strategies for meeting future demands while protecting existing water rights. The water rights adjudication process must be completed as accurately as possible to establish the priority of pre-1973 water rights.

SHORT TERM RECOMMENDATION (0–2 YEARS)

- Continue funding of both the Water Court and the DNRC efforts to complete the current adjudication process at the necessary level of staffing to meet legislatively established benchmarks.

INTERMEDIATE TERM RECOMMENDATION (2–6 YEARS)

- The DNRC and the Water Court should work with stakeholders to evaluate and develop processes to ensure water rights are accurately and consistently defined across Montana.

LONG TERM RECOMMENDATION (6 – 10 YEARS)

- Create a plan for transitioning the state, including the DNRC, the Water Court, and the District Courts, to post adjudication water distribution, management and enforcement roles.

Enforce Against Illegal Water Use

Montana Water users want a more efficient, less expensive, and more administrative approach to water right enforcement. There is growing public sentiment in support of DNRC playing a more active enforcement role against illegal water use.

INTERMEDIATE TERM RECOMMENDATIONS (2–6 YEARS)

- Examine and recommend changes to improve the current administrative process for bringing enforcement action against illegal water use.
- DNRC and the Water Court should create and the Legislature should actively fund a water rights dispute mediation unit to provide an administrative alternative to traditional water rights litigation. Training in dispute resolution and mediation should be available to all water commissioners.
- Review the procedures for establishing water distribution projects based upon Water Court decrees to improve the efficiency of that process.
- Promote consistent legal and professional measurement and distribution of water under decree by requiring water commissioners to complete the DNRC training (MCA 85-5-111) and create a certification process with annual renewals.

LONG TERM RECOMMENDATION (6–10 YEARS)

- Clarify how decrees within subbasins of major adjudicated basins will be administered when a water rights dispute arises between water users in adjacent subbasins.

Provide Sufficient Information, and Legal and Administrative Capacity to Minimize Adverse Effects during Times of Water Scarcity

Climate variation and shifting weather patterns affect average temperatures, the amount, and distribution of precipitation, and whether that precipitation occurs as rain or snow. As a result, seasonal streamflows are likely to change both in volume and timing. Climate variation may lead to an extended growing season and/or higher water use by crops and vegetation. Looking ahead, our water management strategies must adapt to address the highly variable water supply.

INTERMEDIATE TERM RECOMMENDATIONS (2–6 YEARS)

- Drought planning efforts must include legal and administrative mechanisms that enable water users to reduce water use without the risk of abandonment and allow for the water savings to be protected.
- Assess the water right implications and potential adverse effects of allowing a water right holder to change their period of use to adapt to changing runoff and growing seasons.

Analyze Additional Opportunities and Challenges for Using Water Marketing, Mitigation, and Banking as Tools for Meeting New Demands

Compared to many western states, Montana appears to have relatively abundant water supplies, however most of this water may already be appropriated, and many parts of the state are fully allocated and closed to new appropriations. Meeting new water demands requires innovative approaches to address local water deficits within individual sub-basins. Understanding the potential positive and negative impacts of these measures is the first step towards taking advantage of new approaches. The potential for water marketing (the sale of water or the water right by the owner) is high in Montana, especially in closed basins where the value of water increases with new water demands. Mitigation for new uses will require the reallocation of surface water or groundwater through a water right change. There are questions about the scope of water banking and its role in facilitating the reallocation of water, and the potential adverse effects of change authorizations. These issues and opportunities for mitigation, water marketing and water banking require more research, innovation, and application in the next decade.

INTERMEDIATE TERM RECOMMENDATIONS (2–6 YEARS)

- Assess the opportunities, challenges, water right implications, and potential adverse effects of using water marketing, mitigation, and banking as tools for meeting new demands
- Create well-managed systems that offer economic development opportunities to market, transfer and lease water and build public awareness of water marketing opportunities.

Complete all Outstanding Tribal and Federal Compacts and Work Closely with Federal Partners to Better Manage Federal Water Projects

In contrast to many states that resorted to litigation as a method to quantify federal reserved water rights, in 1979, the Montana Legislature chose to establish the Montana Reserved Water Rights Compact Commission. To date the Commission has successfully negotiated, and the Montana Legislature has approved, seventeen compacts: eleven Federal (non-tribal) compacts and six Tribal compacts. A negotiated compact with the Confederated Salish and Kootenai Tribes (CSKT) is awaiting approval by the Montana Legislature.

Montana's water rights adjudication process will not be complete until all Federal and Tribal compacts have been decreed by the Water Court. To reach a final decree, all compacts must be ratified by the Montana Legislature, approved by appropriate federal authorities, and in the case of Tribal compacts approved by Tribes.

All four Basin Advisory Councils agreed that it is in the interest of the state, federal government, and the tribes to complete this important work.

SHORT TERM RECOMMENDATIONS (0-2 YEARS)

- Continue to support and implement all adopted compacts. The state and the state's Congressional delegation must continue working with the tribes and the Departments of Justice and Interior to complete all the federal and tribal water compacts still in process.
- Montana must remain actively engaged in an ongoing dialogue with adjacent states and Canada to protect Montana's interest through the implementation of treaties and compacts that affect Montana's water resources.

WATER INFORMATION

Water resource issues are multi-faceted and often highly localized. Understanding and resolving them requires ready access to up-to-date information. Multiple local, state, federal, and tribal agencies generate and use water information in carrying out their responsibilities related to the protection or allocation of Montana's water resources. Better integration of this information will support planning, policy development and decision making at local, state and federal levels. Integration of information will also support planning and decision making by individual water users. Better access to hydrologic and climatic information at the appropriate geographic scale will result in more accurate assessments of water availability. Improved measurement and monitoring of water use will support the state's ability to determine when water is physically and legally available to meet new demands, while protecting existing water rights. Improved access to integrated water information will also support the work of water managers to distribute water by priority.

Steps for increasing access to information on Montana's water resources include:

Support Improvements to the Montana Water Information System

The Montana State Library's Water Information System (WIS) is the starting point for finding water resource information in Montana. The WIS makes high quality data on surface water, groundwater, water quality, riparian areas, water rights, climate data and more available to the public from one common starting place. Improving the WIS through the development of new data sets, interactive applications, and maps will support informed decision-making and integrated water resource management.

SHORT TERM RECOMMENDATIONS (0–2 YEARS)

- Provide the State Library with additional staff resources dedicated to the development of new water resource related data sets, interactive applications, and maps.
- DNRC will work with the State Library to develop a systematic workflow for revising the Montana Spatial Data Infrastructure (MSDI) Hydrography Framework based on the US Geological Survey National Hydrography Dataset (NHD).
- Develop a process for transmitting water data generated by local, state and federal agencies, and watershed groups to the State Library for inclusion in the WIS in a consistent and timely fashion.
- Continue working with the U.S. Geological Survey on the development of StreamStats—an interactive Web-based map application for providing streamflow statistics on streams and rivers with limited hydrologic information.

INTERMEDIATE TERM RECOMMENDATION (2–6 YEARS)

- Improve the spatial representation of points of diversion (PODs) and places of use (POUs) associated with water rights, and make this improved representation available through the WIS.

Inventory of Consumptive and Non-Consumptive Uses

An accurate inventory of Montana's water use, both consumptive and non-consumptive, is critical to the state's ability to quantify current use and determine the amount of water legally and physically available to meet new demands. Accurate information on historic water use is required to evaluate potential adverse effects of changes in use.

INTERMEDIATE TERM RECOMMENDATIONS (2–6 YEARS)

- Invest in the resources necessary to acquire the best information available on current consumptive and non-consumptive water use in Montana. This includes accurate information on the extent and distribution of irrigated lands, crop types, and irrigation system types.
- Develop the capability to use Geographic Information System (GIS) technology and specialized agricultural engineering software to calculate the amount of water consumed by plants (evapotranspiration) using available information generated from NASA's Landsat Program.
- Explore the development of standard practices for evaluating consumptive use from analysis of Landsat imagery.
- Provide technical assistance and incentives to water users to measure water at or near the point of diversion from a ditch, stream, or wellhead.

Monitor Water Supply and Distribution

Effective water management and distribution depend on accurate real-time measurements of streamflow, snowpack and soil moisture. Improving Montana's water supply and distribution monitoring network will improve the ability of water managers and water users to adjust to seasonal supply and demand imbalances as well as plan for longer term imbalances associated with climate variability.

DNRC currently provides funds to operate and maintain forty-four (44) real-time stream gages in Montana through the U.S. Geological Survey's (USGS) Cooperative Water Program (Co-Op Program). These gages provide

real-time flow information on the state's main rivers and larger tributaries. Other critical water supply monitoring systems include both SNOTEL (SNOw TELemetry), a system operated by the Natural Resource Conservation Service (NRCS) that measures mountain precipitation and other atmospheric conditions, and SCAN (Soil Climate Analysis Network), a system operated by NRCS that measures soil moisture. All of this information is available to water users via the Montana Drought and Water Supply website (drought.mt.gov). Montana must work to ensure the continued operation of these water supply monitoring networks.

SHORT TERM RECOMMENDATIONS (0–2 YEARS)

- Expand the funding base for the USGS Co-Op Program beyond traditional state and federal agency partners by educating local organizations and private entities on the purpose and need for stream gages.
- Begin to develop a network of 100 state operated permanent, year-round stream gages to gather and distribute real-time streamflow information on smaller streams and tributaries not monitored through the USGS Co-Op Program.
- Encourage support of all existing sites and further expansion of the NRCS's SNOTEL and SCAN systems to provide actionable and long term water supply and soil moisture condition data.

Improve and Expand Efforts to Quantify Groundwater Supplies and Availability

Montanans are increasingly looking to the state's groundwater to meet future needs. Groundwater information including aquifer characteristics and water monitoring data collected under the Montana Bureau of Mines and Geology Groundwater Water Assessment Program is needed statewide to identify sources of groundwater potentially available for development.

SHORT TERM RECOMMENDATION (0–2 YEARS)

- The Montana Bureau of Mines and Geology's (MBMG's) Groundwater Steering Committee should re-assess the criteria used in selecting studies conducted under both the Groundwater Assessment and Groundwater Investigation Programs to better reflect critical needs and statewide priorities.

INTERMEDIATE TERM RECOMMENDATION (2–6 YEARS)

- Provide additional funding to MBMG's Groundwater Characterization Program (GWCP) for the purpose of completing reconnaissance level inventories of groundwater resources in the remaining GWCP characterization areas.
- Provide necessary funding to expand MBMG's Groundwater Monitoring Program for the purpose of adding dedicated monitoring wells to characterize trends in groundwater levels.

Improve Conjunctive Management of Surface Water and Groundwater

Montana recognizes the link between surface water and groundwater and manages them as a single resource. Additional site-specific investigations to determine aquifer properties are necessary: to evaluate interactions between groundwater and surface water, develop strategies for mitigating impacts of groundwater use on surface water users, and to facilitate decisions on new permitting and water right change authorizations.

INTERMEDIATE TERM RECOMMENDATIONS (2–6 YEARS)

- Support continued funding for the MBMG's Groundwater Investigation Program to ensure that aquifer information and modeling tools necessary to implement conjunctive management are available.
- Identify options for mitigation or aquifer recharge plans to offset impacts of groundwater use on surface water.
- Investigate the availability and the potential for the diversion of high spring surface water flows for aquifer recharge.
- Investigate the design of aquifer storage and recovery projects to optimize water use while protecting existing water users.

ECOLOGICAL HEALTH AND ENVIRONMENT

Montana's aquatic systems, lakes and rivers, and associated biological resources, support our quality of life, provide clean drinking water, and support Montana's recreation and tourism economy. The availability of water in the appropriate quantity, quality, timing and duration is necessary to ensure the health of our water-dependent ecosystems. The state should pursue proactive policies and management practices to meet the needs of aquatic ecosystems within the prior appropriation system in order to sustain the health of these valuable natural systems as Montana's economy grows.

Steps to address these issues include:

Provide Sufficient Protection for Instream Flows Within the Prior Appropriation Framework to Maintain Aquatic and Riparian Systems

Coordinated efforts are needed to develop and implement strategies and tools for providing minimum instream flow regimes within the prior appropriation framework.

INTERMEDIATE TERM RECOMMENDATIONS (2–6 YEARS)

- Ensure that the change of use process for instream flow/fishery water rights is consistent with the change process for all other beneficial uses. Steps would include a requirement that the applicant show they will not adversely affect other water right holders, the allowance of both temporary and permanent changes, and a broader recognition that instream flow rights should be enforced in priority.
- Recognize and document the importance of connectivity within stream and riparian systems. Efforts should

be made to restore connectivity and habitat where needed within the prior appropriation doctrine.

- Support research to determine the frequency, magnitude, timing and duration of high flows and low flows needed to maintain the natural ecological functions of rivers, streams and habitats across the state.

Support Proactive, Coordinated Efforts to Reduce Invasive Species and Protect Endangered Species in Montana

Both aquatic and terrestrial invasive species can impact water supplies and distribution. Zebra mussels, Eurasian watermilfoil and Tamarisk (saltcedar), colonize quickly, out-compete native species, wreak havoc on water delivery infrastructure, threaten native aquatic ecosystems and/or consume large amounts of water. The presence of threatened and endangered species requires careful management decisions and cross agency coordination to minimize negative impacts to critical habitat and to water users. Coordinated efforts are needed to implement actions that protect Montana's land and water resources.

SHORT TERM RECOMMENDATIONS (0-2 YEARS)

- Promote the use of voluntary programs that preserve the flexibility of landowners to manage their operations as the preferred method for handling Endangered Species Act protection and recovery programs.
- Support local and agency coordination efforts to implement invasive species protection programs.

COLLABORATIVE WATER PLANNING AND COORDINATION

Water management in Montana occurs at a variety of scales: watershed, sub-basin, basin, statewide and regional. Many local, state, federal, and tribal agencies and organizations are involved in the distribution, protection, and/or measurement of Montana's water. Coordination increases communication, improves efficiencies, and leverages technical and financial resources. Effective collaboration helps to inform, engage, and connect stakeholders and supports efforts to improve water management across all watersheds. It is important to coordinate efforts and involve water managers, users, and stakeholders at the watershed, basin, and statewide scale to develop sustainable management solutions.

Expand Support for Basin and Community Based Watershed Planning

Community-based watershed groups, conservation districts, and other organizations provide the structure and a forum to bring together stakeholders, build partnerships, and work collaboratively to develop local water management plans. It will be increasingly important to provide such groups with planning support, technical assistance, and access to information to develop, implement, and monitor water use plans as demand for water grows and the administration of Montana's water becomes more complex.

SHORT TERM RECOMMENDATION (0–2 YEARS)

- Provide funding to periodically convene the Basin Advisory Councils to evaluate, update and implement the recommendations adopted in the State Water Plan.

INTERMEDIATE TERM RECOMMENDATIONS (2–6 YEARS)

- Create a dedicated and sustainable source of funds to support technical, organizational and operational capacity of local watersheds to assist in water management and drought planning, education and outreach, and the coordination of local efforts to implement state and basin plan recommendations.
- Build on the work of the statewide organizations such as the Montana Association of Conservation Districts and the Montana Watershed Coordination Council to provide financial, technical and educational assistance to increase the organizational capacities of community based watershed groups and Conservation Districts.

Encourage Collaboration, Coordination, and Communication across Local, State, and Federal Agencies and Tribal Governments

Many state and federal agencies and tribes share responsibilities for land and water management. The policies and actions of one often directly impact another. Close coordination between local, state, federal and tribal water managers is critical for achieving outcomes that serve both economic and environmental interests. Local, state and federal agencies and Tribes in Montana must work closely to:

SHORT TERM RECOMMENDATION (0–2 YEARS)

- Address watershed, sub-basin and basin wide water management issues through increased interaction and communication between water users, watershed groups, technical specialists, and policy makers at all levels of government.

INTERMEDIATE TERM RECOMMENDATION (2–6 YEARS)

- Encourage land management agencies to include potential impacts to water supplies in their management decisions. This could include forest vegetation management and the restoration of natural features such as riparian areas and wetlands that act to slow runoff and promote groundwater recharge.

Develop a Plan to Deliver Water Related Training, Education and Outreach

Water management is complicated, not only because of water's finite and variable nature, but also because of the complicated nature of the water right laws and rules used to administer it. Water education and outreach activities are necessary to provide a foundation for the informed management of Montana's water resources now and into the future.

SHORT TERM RECOMMENDATION (0–2 YEARS)

- DNRC will expand on current efforts to create and deliver public awareness and training programs, working through the Montana Watercourse, Conservation Districts, Water Quality Districts, municipalities and community-based watershed groups that provide information on
  - Water efficiency and hydrology related topics:
    - Benefits and consequences of sprinkler and flood irrigation system conversions,
    - Municipal water conservation measures,
    - Consumptive and non-consumptive use,
    - Groundwater/ surface water interactions.
  - Water Rights Administration:
    - Water right basics,
    - The process to obtain water for new or expanded uses,
    - DNRC's improved/simplified change process,
    - The process for filing an objection to an application for a new, expanded, or changed use of water,
    - Water reservations, legal status and availability for development as a beneficial use.
  - Adjudication and Tribal and Federal Compacts progress and outcomes
  - How to access water data through the Water Information System
  - Technical trainings, assistance and incentives to support voluntary water measurement programs
  - Educate local organizations and private entities on the value, purpose, and need for stream gages, as well as how and where to access the data.

INTERMEDIATE TERM RECOMMENDATION (2–6 YEARS)

- Develop an easily navigable webpage or portal that provides public information on water contracting/leasing opportunities and for identifying all the elements of a water right including: ownership, beneficial use, point of diversion, place and period of use.

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APPENDIX A GLOSSARY OF TERMS

Abandonment – The intentional, prolonged, non-use of a perfected water right. [1]

Acre-feet – A unit of volume, mostly used in the United States, to describe large-scale water volumes. It is the volume of one acre of surface area to the depth of one foot which is equal to 43,560 cubic feet.

Adjudication of Water Rights – In the context of Montana water law this refers to the statewide judicial proceeding to determine the type and extent of all water rights claimed to exist before July 1, 1973.[2]

Adverse Effect – Interference with a water right owner's ability to reasonably exercise their water right. In the context of new water use permits and change applications, the applicant must prove lack of adverse affect prior to appropriating water for a beneficial use pursuant to §85-2-311, MCA, or changing a water right pursuant to §85-2-402, MCA. [3]

Appropriate – To divert, impound, or withdraw, including by stock for stock water, a quantity of water for a beneficial use.[1]

Appropriation Right/Water Right – Any right to the beneficial use of water which would be protected under the law as it existed prior to July 1, 1973, and any right to the beneficial use of water obtained in compliance with the provisions and requirements the Title 85, Chapter 2.[1]

Aquatic Ecology – The relationships among aquatic living organisms and between those organisms and their water environment.

Aquatic Invasive Species – Non-native plants, animals or pathogens that cause environmental or economic harm.

Beneficial Use – Use of water for the benefit of the appropriator, other persons, or the public, including but not limited to agricultural (including stock water), domestic, fish and wildlife, industrial, irrigation, mining, municipal, power, and recreational uses; use of water to maintain and enhance streamflows to benefit fisheries pursuant to conversion or lease of a consumptive use right. [1]

Call – The request by an appropriator for water which the person is entitled to under his/her water right; such a call will force those users with junior water rights to cease or diminish their diversions and pass the requested amount of water to the downstream senior water right holder making the call.

Claim/Statement of Claim – The assertion that a water right exists under the laws of Montana or that a reserved water right exists under the laws of the United States in Montana's general adjudication. [2]

Climate – The average weather over a period of time, typically taken as a 30-year period from a human perspective. Geologists and paleoclimatologists refer to the earth's climate over thousands to millions of years.

Climate Variability – The fluctuation of temperature, precipitation, wind, and other climate descriptors, over a period of time. This variation may be due to natural processes or human-induced factors.

Compact – a negotiated agreement for the equitable division and apportionment of waters between the State and its people and: 1) the several Indian Tribes claiming reserved water rights within the state (MCA 85-2-701); or, 2) between the State and its people and the federal government claiming non-Indian reserved waters within the state.

Conjunctive Management – Management of ground and surface water as a single resource.

Conjunctive Use – The deliberate combined use of groundwater and surface water.

Conservation District – A political subdivision of state government, possessing both public and private attributes, that primarily distributes irrigation water in a given region and that may also administer electric power generation, water supply, drainage, or flood control.

Consumptive Use – Use of water that reduces supply, such as irrigation or household use.[1]

Decree – Is a final product of adjudication and is a legal document issued by a district court or the Montana Water Court defining the priority, amount, use, and location of a water right or set of water rights. The Montana Water Court adjudicates and prepares decrees for entire basins as part of the adjudication process.[2]

Dewatering of Streams, Chronic and Periodic – Dewatering is a reduction in stream flow below the point where stream habitat is adequate to support healthy fish populations. Chronic dewatering is a significant problem in all years while periodic dewatering is a significant problem only in drought years.

Means of Diversion/Diversion – Structures, facilities, or methods used to appropriate, impound, or collect water including but not limited to a dike, dam, ditch, headgate, infiltration gallery, pipeline, pump, pit or well. [1]

Evapotranspiration (ET) – means the loss of water from the soil both by evaporation and by transpiration from living plants. Evaporation accounts for the movement of water to the air from sources such as the soil, canopy interception, and water bodies. Transpiration accounts for the movement of water within a plant and the subsequent loss of water as vapor through stomata in its leaves. [1]

Exempt Wells – Under Montana water law, wells that divert 35 gallons per minute or less, and do not exceed 10 acre-feet per year in the total volume of water diverted are considered exempt from the permitting process. Appropriators of water under these conditions are, however, required to file a notice of completion with DNRC.[4]

Existing Water Right – "Existing right" or "existing water right" means a right to the use of water that would be protected under the law as it existed prior to July 1, 1973. The term includes federal non-Indian and Indian reserved water rights created under federal law and water rights created under state law. [1]

Federal or Tribal Reserved Water Rights – Established by an act of Congress, a treaty, or an executive order. Gives a right to use water; the amount of water reserved depends on the purpose for which the land was reserved.

Flowing Well – An oil or water well from which the product flows without pumping due to natural or artificially supplied subterranean pressure.

Flow Rate – A measurement of the rate at which water flows or is diverted, impounded, or withdrawn from the source of supply for beneficial use, and commonly measured in cubic feet per second (cfs) or gallons per minute (gpm). [1]

Geographic Information System (GIS) – A computer system designed to capture, store, manipulate, analyze, manage, and present geographical data.

Groundwater – Any water beneath the land surface.[1]

Groundwater Recharge or Aquifer Recharge – Can refer both to the natural process of groundwater recharge (achieved by infiltration of precipitation or discharge from surface water), OR can refer to human efforts to enhance more groundwater storage. Artificial aquifer recharge (AR) is the enhancement of natural groundwater supplies using man-made conveyances such as infiltration basins or injection wells. Aquifer storage and recovery (ASR) is a specific type of AR practiced with the purpose of both augmenting groundwater resources and recovering the water in the future for various uses.[1]

Hydraulic Conductivity – the capacity of a unit thickness of an aquifer to transmit water per unit width and unit gradient.

Hydrologic Regime – The relationship between precipitation inputs and streamflow outputs in a basin or watershed. The amount and timing of water moving through a watershed often characterized by the average annual hydrograph.

Hydrograph – A chart showing the relationship between flow rate and time at given point (gage) in a watershed flow network. Time is usually on the horizontal axis and flow rate is usually on the vertical access.

Instream Flow – Water left in a stream for non-consumptive uses such as aquatic habitat, recreation, navigation, or hydropower.

Interstate Compact – A legal agreement between two states that divides (or apportions) water crossing the states' boundaries.

Junior Appropriator/Junior Water Right – A general term referring to a water right or the owner of a water right with a priority date that is later in time than another water right.

Channel Migration – Natural movement of river channels through the processes of erosion and deposition.

Legal Water Availability – Typically determined based upon comparison of physical water availability to the legal demands on a source or reach of a source by subtracting the legal demands from physical water availability. [3]

METRIC (Mapping Evapotranspiration at high Resolution and with Internalized Calibration) – An image-processing tool for computing evapotranspiration (ET) using Landsat Thematic Mapper data.

Montana Code Annotated (MCA) – Laws of Montana classified by subject. Title 85 contains laws pertaining to water use.

Murphy Rights – Instream flow rights on 12 Blue Ribbon trout streams for the preservation of fish and wildlife. Named for the legislative author, Jim Murphy of Kalispell. Murphy Rights exist for specific reaches of the following rivers: Big Spring Creek, Blackfoot River, Flathead River, Middle Fork Flathead River, South Fork Flathead River, Gallatin River, West Gallatin River, Madison River, Missouri River, Rock Creek, Smith River, and Yellowstone River. The priority dates are 1970 and 1971 and only protect flows when senior water rights have been satisfied.

Natural Storage of Water – See storage of water, natural.

Non-Consumptive Use – Use of water that does not consume water.

Overstated Water Rights – Water rights in excess of what was perfected through beneficial use.

Permit – An authorization to use water, issued by DNRC, specifying conditions such as type, quantity, time, and location of use. [3]

Physical Water Availability – the amount of water physically available at a specific point on a source typically measured in flow rate and volume. [3]

Priority Date – The clock time, day, month, and year assigned to a water right application or notice upon DNRC acceptance of the application or notice. The priority date determines the ranking among water rights. [1]

Federal Reserved Water Right – A special water right accompanying federal lands or Indian reservations, holding a priority date originating with the creation of the land.

Resource Indemnity Trust – Article IX of the Montana Constitution provides for the protection and improvement of the Montana environment and requires the existence of a resource indemnity trust (RIT) fund for that purpose, to be funded by taxes on the extraction of natural resources.

Return flow – Part of a diverted flow that is applied to irrigated land or other beneficial use and is not consumed and returns underground to its original source or another source of water. Other water users may be entitled to this water as part of their water right. [1]

Riparian – Riparian means related to or situated on the banks of a river. A riparian zone or riparian area is the interface between land and a river or stream.

Riverine Processes – The processes of erosion, transport and deposition of sediment that shape a river's channel(s) and floodplain.

Senior Appropriator/Senior Water Right – A general term referring to a water right or the owner of a water right with a priority date that is earlier in time than another water right.[1]

Storage of Water, Artificial or Constructed – Storing water in reservoirs or other human made impoundments.

Storage of Water, Natural – Storage of water in natural landscape features such as groundwater aquifers, ponds (including beaver ponds, floodplain ponds), wetlands and swales.

Stream Depletion Zone – An area where hydrogeologic modeling concludes that as a result of a groundwater withdrawal, the surface water would be depleted by a rate equal to a rate of at least 30% of the groundwater withdrawn within 30 days after the first day a well or developed spring is pumped at a rate of 35 gallons a minute. [1]

Stream Gage – A stream gage measures the flow of water at a point along a stream. The U.S. Geological Survey defines a stream gage as, "an active, continuously functioning measuring device in the field for which a mean daily streamflow is computed or estimated and quality assured for at least 355 days of a water year or a complete set of unit values are computed or estimated and quality assured for at least 355 days of a water year".

Sub-basin – A structural topographic feature where a basin forms within a larger basin. For example, the Bitterroot River basin is sometimes referred to as a sub-basin of the Clark Fork River basin.

Surface water – All water of the state at the surface of the ground, including but not limited to any river, stream, creek, ravine, coulee, undeveloped spring, lake, and other natural surface source of water regardless of its character or manner of occurrence.[1]

Telemetered (real-time) Stream Gage – A telemetered gage has the capability to transmit water elevation and streamflow data to a central location where it may be viewed (for example, via the Internet) as the data is collected.

Waste – Unreasonable loss of water through the design or negligent operation of an appropriation or water distribution facility or the application of water to anything but a beneficial use. [1]

Water Bank – An institutional mechanism used to facilitate the legal transfer and market exchange of various types of surface water, groundwater, and storage entitlements. Water banks use the market to make water available for new uses.

Waterway and Water Body – Usually refers to surface water features like rivers, streams, lakes, or ponds.

Waterway Health – Waterways are considered to be healthy when surface & groundwater flows & levels are of a timing and duration that provides habitat capable of supporting self-sustaining populations of native fish species and water dependent wildlife. In addition, waterway health refers to flows that help meet water quality standards, support beneficial uses, and support stream renewal functions.

Water Commissioner – Local water users can petition for a water commissioner after the water rights in a basin have been verified by the Montana Water Court. The commissioner ensures that daily water allocations in the basin occur in accordance with the users' rights. The local district court appoints the commissioner, and oversees his or her work. [5]

Water Court – Located in Bozeman, the Montana Water Court's primary function is to carry out the state-wide adjudication. Disputes between water right holders are still handled in local district court, and the local district courts oversee water commissioners in their area.

Water Lease – An agreement with a water user to allow a person or organization, for a fee, to lease water from the user. Water leases are often used in Montana to maintain instream flow.[6]

Water Quality – Chemical, physical, and biological characteristics of water that determine its suitability for a particular use.

Water Right Change – A change in the place of diversion, the place of use, the purpose of use, or the place of storage of a water right. These changes need the approval of DNRC to assure that the change will cause no adverse affect to other water users. [3]

Watershed – All the land that drains to a river or lake, with boundaries defined by topography (and includes wetlands, floodplains, riparian areas and uplands). For the purpose of this planning document, the term "watershed" is referring to a subunit of a sub-basin (smaller area).

Watershed Health – A watershed is considered healthy if it can continue to perform without depletion or degradation of watershed services such as: water collection, storage & delivery, flood and drought moderation; water purification, wildlife habitat and support of waterway health (see Waterway Health).

Water Reservation – A water right created under state law after July 1, 1973, that reserves water for existing or future beneficial uses or that maintains a minimum flow, level, or quality of water throughout the year or at periods or for defined lengths of time. [7]

[1] See §85-2-102, Mont. Code Ann., and Rule 36.12.101, Admin. Rules Mont.
[2] See Title 85, Chapter 2, Part 2, Mont. Code Ann.
[3] See §85-2-311, and 402, Mont. Code Ann., and Title 36, Chapter 12, Subchapters 17 through 19. Admin. Rules Mont.
[4] See §85-2-306, Mont. Code Ann.
[5] See Title 85, Chapter 5, Mont. Code Ann.
[6] See Title 85, Chapter 2, Part 4, Mont. Code Ann.
[7] See §85-2-316, Mont. Code Ann.