



Big Sky Area Sustainable Watershed Stewardship Plan



January 26, 2018

BIG SKY AREA SUSTAINABLE WATERSHED STEWARDSHIP PLAN

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Big Sky Sustainable Water Solutions Forum

Big Sky, MT

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Over 2016-2017, the Gallatin River Task Force hosted a collaborative stakeholder driven effort to develop the Big Sky Area Sustainable Watershed Stewardship Plan. The Gallatin River Task Force (Task Force) is a nonprofit organization headquartered in Big Sky, with a focus on protecting and improving the health of the Upper Gallatin River and its tributaries.

I would like to take this opportunity to thank the many entities and individuals involved in this effort. The main funders of plan development included the Big Sky Resort Area Tax District, and Gallatin and Madison Counties. Initial seed funding was provided by the Big Sky Water and Sewer District, Lone Mountain Land Company, and the Yellowstone Club.

Thank you to the stakeholders and their representative organizations that contributed time, energy, and brain power to become educated in water issues in the Big Sky Community, roll up their sleeves and spend countless hours developing creative solutions to complex water issues. Thank you to the many member of the public who provided input by attending stakeholder and public meetings or taking our survey.

Implementation of this plan will ensure that the ecological health of our treasured river systems are enhanced and protected as our community and region continue to grow in residential and visitor population. Cold, clean and abundant water will be critical to sustain the many attractions to the Big Sky area that include our free-flowing rivers, abundant wildlife, world class recreational opportunities, and scenic landscapes

This is an ambitious plan and success of this plan will depend entirely on strong community engagement, partnerships, and support in implementation.

Now is the time to get involved! Thank you for taking the first step by reviewing this plan.

Kristin Gardner
Executive Director
Gallatin River Task Force

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EXECUTIVE SUMMARY

The Big Sky Sustainable Water Solutions Forum (Water Forum) is a community-based, collaborative approach building a unified vision for future Big Sky water resources management to maintain and enhance ecologically healthy river systems in the community and downstream while also identifying sustainable solutions for community water supply and wastewater treatment challenges.

The Water Forum was convened to:

- Unify efforts to address water resources for the Big Sky area and surrounding zone of influence in three co-equal water resources focus areas:
 - Ecological Health of River Systems
 - Water Supply and Availability
 - Wastewater Treatment and Reuse
- Develop recommendations for solutions and actions to address current and future water needs for both the natural and human communities
- Support community implementation of the solutions

The Big Sky Area Sustainable Watershed Stewardship Plan addresses water resources issues in the Big Sky area, which includes the West Fork Gallatin River watershed, Jack Creek watershed, and the Gallatin River mainstem and tributaries between the Corral and Karst (Highway 191 Mile Markers 42 through 55). Since the developed areas are not incorporated, the Big Sky Resort Area District boundary was established to characterize the Big Sky area for planning purposes. An associated zone of influence of the Madison and Gallatin watersheds was also identified as important since the entire area is linked through its water resources, transportation corridors, and economic base.

WATER FORUM STAKEHOLDERS AND DECISION-MAKING PROCESS

The Water Forum is a diverse, community-based stakeholder group formed to identify and recommend priorities and actions to address water resources stewardship in the Big Sky area. The Water Forum was convened in June of 2016 following an extensive community assessment process in the spring of 2016. The Gallatin River Task Force (Task Force) hosted the Water Forum and an advisory committee guided the process. Participation as a stakeholder in the Water Forum was voluntary, and all stakeholders agreed to commit to engagement in the process and a set of ground rules. Water Forum stakeholder meetings were open to the public and members of the community participated throughout the process. Water Forum stakeholders were selected to represent community, conservation, business, agricultural, government, and agency perspectives in the Big Sky area and downstream and stakeholders have a wide variety of expertise in water resources, economic and community issues. Water Forum stakeholders and other community members worked from June 2016 to November 2017 to identify opportunities and challenges, determine desired outcomes, and develop recommendations to achieve their goals and objectives. Decisions on goals, objectives and recommended priorities and actions were made through consensus.

CHALLENGES IN ADDRESSING WATER RESOURCES ISSUES

Water Forum stakeholders identified challenges to the effective stewardship of water resources in the Big Sky area. Some challenges, like limited water supplies, are boundaries the community must work within. Other challenges, like political, organizational, and management fragmentation, are human factors that can be managed and perhaps changed.

Within each of the three co-equal focus areas, water resources challenges include:

The Ecological Health of the River Systems has been impacted by changes in water quality and instream habitat. Three streams in the Big Sky area have water quality conditions that fail to meet Montana’s water quality standards, including the Middle Fork West Fork Gallatin River, South Fork West Fork Gallatin River, and West Fork Gallatin River. Monitoring has been ongoing in the Gallatin and Madison watersheds in the Big Sky area, but significant questions remain about the status and trends of water quality, streamflows, riparian areas, wetlands, fisheries, and aquatic life because of gaps in the monitoring network and in community understanding. Growth, climatic variability, drought, and cumulative impacts from land use and recreation also challenge the future ability to preserve high quality river, riparian and wetland systems.

Water Supply and Availability are affected by increasing levels of development and predicted changes to precipitation and runoff patterns. Limited groundwater and surface water resources are not fully characterized and there are gaps in status and trends monitoring and modeling. Groundwater withdrawals from individual and community wells can have a significant impact on the availability of fresh water supplies and streamflows in the Big Sky area and downstream. Projections for water supply needs suggest that current capacity to meet community needs will be met by 2025 in some areas and no further water rights can be allocated in the Gallatin or Madison watersheds.

Wastewater Treatment and Reuse is affected by the types of infrastructure, level of treatment, rate of growth, and current capacity for wastewater treatment, storage and reuse. Given the predicted level of growth in the Big Sky area and the accompanying challenges for wastewater treatment, storage, and reuse capacities, along with increasing densities of individual septic systems, treating wastewater to the limits of technology will create more options for beneficial reuse. Predicted increases in effluent generation necessitate the identification and development of suitable reuse alternatives.

WATERSHED STEWARDSHIP RECOMMENDATIONS TO THE COMMUNITY

The vision of the Big Sky Sustainable Water Solutions Forum is:

“Big Sky strives to be a model mountain community by protecting and improving water resources, sustaining ecological health of the watersheds, and supporting a vibrant local economy.”

Water Forum stakeholders emphasized that recommended alternatives must sustain the ecological health of the river systems and meet the needs of the growing mountain community. Water Forum stakeholders reached consensus on recommendations for the three water resources focus areas on priorities and actions to address the Big Sky area’s water resources challenges. The consensus recommendations meet the vision and goals developed by the Water Forum and are supported by the diverse interests represented by the stakeholders.

Consensus recommendations for sustainable watershed stewardship in the three water resources focus areas are:

Ecological Health of the River Systems: *A healthy and resilient river system sustained through a principled approach to watershed stewardship that includes human activities and natural processes that maintain and enhance stream, riparian and wetland conditions and connections, ensuring water remains clean and cold.*

Recommended Priorities:

1. Watershed Status and Trends Monitoring Program
2. Watershed Status and Trends Dashboard
3. Watershed Restoration and Conservation

Recommended Actions:

1. Establish a Watershed Status and Trend Monitoring Program, which will include an expanded water quality monitoring network to track water quality trends, fill identified data gaps, provide baseline information for permitting actions, and identify areas for restoration and conservation activities.
2. Develop a Watershed Status and Trends Dashboard to convey information collected in the Watershed Status and Trends Program to the community.
3. Implement Watershed Restoration and Conservation actions that address water quality impairments and protect the existing high-quality water resources by maintaining connectivity in the hydrologic and biologic systems of the Big Sky area.

Water Supply and Availability: *Manage and balance surface and groundwater supplies for a vibrant community sustaining a broad spectrum of uses and values including fisheries, wildlife, recreation, agriculture, municipal and domestic needs.*

Recommended Priorities:

1. Groundwater Monitoring and Modeling
2. Strategies for Water Conservation
3. Stormwater Management
4. Wastewater Reuse
5. Mitigation of Water Rights

Recommended Actions:

1. Expand Groundwater Modeling and Monitoring to accurately characterize the available water supply in the Big Sky area by generating seasonal outlook reports for groundwater supplies, modeling the impacts of various climate scenarios, modeling various withdrawal amounts, developing real-time data on groundwater and surface water, and developing a water balance to identify “targets” or “triggers” for action.
2. Develop Strategies for Water Conservation to inspire community members to actively engage in water conservation to reduce groundwater withdrawals, maintain instream flows, and build resilience against changing climatic conditions.

3. Improve Stormwater Management to “slow the flow” of water through the system to provide for aquifer recharge and increased late-season streamflows, while also providing resiliency for changing climatic conditions.
4. Expand Wastewater Reuse options that benefit water supply, including Expanding Water Reuse for Irrigation, Developing Water Reuse for Snowmaking, and Investigating Shallow Groundwater Recharge.
5. Develop Mitigation of Water Rights over the long-term. In the near-term, maintain an open dialogue with State agencies and senior water rights holders on water rights adjudication, modifications to the change process, and the potential implications of mitigation.

Wastewater Treatment and Reuse: *Develop and implement holistic wastewater and stormwater management, utilizing best available technologies and practices, to meet Big Sky’s long-term community needs and protect and improve the ecological health of the river systems.*

Recommended Priorities:

1. Treat Wastewater to the Limits of Technology
2. Address Septic Systems and Small Community Systems
3. Expand Water Reuse for Irrigation
4. Develop Water Reuse for Snowmaking
5. Investigate Shallow Groundwater Recharge

Recommended Actions:

1. Treat Wastewater to the Limits of Technology to ensure that wastewater generated in the Big Sky area doesn’t negatively impact the ecological health of the river systems.
2. Address Septic Systems and Small Community Systems, which can contribute significantly higher nutrient loads than advanced centralized treatment systems.
3. Expand Water Reuse for Irrigation on local golf courses and other open spaces, modernize irrigation management, and improve tracking and monitoring of irrigation water to ensure that land applied wastewater is fully consumed by plant uptake and is not inadvertently seeping into the shallow groundwater system and flowing into adjacent streams.
4. Develop Water Reuse for Snowmaking with treated wastewater effluent to support the recreation-based economy and provide for water storage and runoff patterns in sync with the natural hydrologic cycle.
5. Investigate Shallow Groundwater Recharge to augment existing groundwater resources.

In addition to the five areas with consensus recommendations for Wastewater Treatment and Reuse, Water Forum stakeholders discussed the pros and cons of directly discharging treated wastewater effluent into the river systems and the potential for direct or indirect potable reuse. Water Forum stakeholders were unable to reach consensus on where or if these two reuse alternatives should be included on the list of priorities outlined within this watershed stewardship plan.

EXPECTED BENEFITS OF SUSTAINABLE WATERSHED STEWARDSHIP

The Water Forum's recommendations address challenges associated with supporting a human community and four-season resort in an ecologically sensitive semi-arid mountain environment situated at the headwaters of the Gallatin River and Madison River watersheds. All recommendations for sustainable watershed stewardship support one or more of these key concepts:

Understand and track the ecological health of river systems: Detailed understanding of trends and impacts to water quality, water supply, streamflows, groundwater recharge, riparian and wetland health, and instream habitat and fisheries is essential for tracking and evaluating progress.

Maximize valuable water assets: Limited groundwater and surface water supplies and properly treated wastewater are considered highly valuable to this headwaters community.

Slow the flow of water through the watershed: Having sufficient water available during low-flow times of the year is essential for both the ecological health of the river systems and community health. This requires methods for slowing the flow of water through the groundwater, surface water and stormwater systems.

Address existing impacts: Ongoing development, current and past land-use practices, and impacts from increasing recreational pressures have negatively impacted water quality, riparian and wetland health, and instream habitat and fisheries in some areas. Addressing these impacts and changing future management and community norms is critical to meeting stakeholder goals.

Preserve and enhance high quality water resources: Maintaining and enhancing stream, riparian and wetland areas and ensuring the prevention of further cumulative impacts, will help maintain water quality, fisheries, wildlife and scenic values, and support the recreation-based economy.

WATERSHED STEWARDSHIP PLAN IMPLEMENTATION

To implement the Water Forum's recommendations for the Big Sky area, partners at all levels will need to commit to work together. Ongoing coordination and increased organizational capacity will be necessary to accomplish the goals of this watershed stewardship plan and estimated funding requirements for implementation are included in **Table E-1**.

Recommendations for Implementation include:

1. Specific working groups of community partners that coordinate to accomplish recommendations
2. Immediate priorities to work on include expanding the monitoring network, developing wastewater reuse alternatives, improving water conservation, and enhancing community engagement
3. Establishment of long-term sustainable funding to support necessary coordination, monitoring, outreach, and project implementation

Table E-1. Estimated Funding Requirements for Watershed Stewardship Plan Implementation

Focus Area	Quick Start (2018) (1 Year)	Short-term (2019-2023) (5 Years)	Mid-term (2024-2028) (5 Years)	Long-term (2029+) (5+ Years)
Ecological Health of River Systems				
Watershed Status and Trends Monitoring Program	0-100	500-1,000	500-1,000	500-1,000
Watershed Status and Trends Dashboard	0-100	500-1,000	0-100	0-100
Watershed Restoration and Conservation	0-100	500-1,000	1,000+	1,000+
Water Supply and Availability				
Groundwater Monitoring and Modeling	0-100	100-500	100-500	100-500
Strategies for Water Conservation	0-100	100-500	100-500	100-500
Stormwater Management	0-100	100-500	100-500	1,000+
Mitigation of Water Rights	0	0-100	100-500	100-500
Wastewater Treatment and Reuse				
High Treatment Levels for Treated Wastewater	0-100	1,000+	1,000+	1,000+
Address Septic Systems and Small Community Systems	0-100	100-500	100-500	1,000+
Expand Water Reuse for Irrigation	0-100	500-1,000	500-1,000	100-500
Develop Water Reuse for Snowmaking	0-100	1,000+	1,000+	1,000+
Investigate Shallow Groundwater Recharge	0	0-100	0-100	100-500
Total	0-1,000	4,400-8,200+	4,500-7,700+	6,000-8,600+
Annual	0-1,000	880-1,640+	900-1,540+	1,200-1,720+
Funding requirements estimated in dollars x1,000	0-100	100-500	500-1,000	1,000+

1.0 INTRODUCTION

The Big Sky Area Sustainable Watershed Stewardship Plan addresses water resources issues in the Big Sky area, which includes the West Fork Gallatin River watershed, Jack Creek watershed, and the Gallatin River mainstem and tributaries between the Corral and Karst (Highway 191 Mile Markers 42 through 55). Since the developed areas are not incorporated, the Big Sky Resort Area District boundary was established to characterize the Big Sky area for planning purposes. An associated zone of influence of the Madison and Gallatin watersheds was also identified as important since the entire area is linked through its water resources, transportation corridors, and economic base.

The Big Sky Sustainable Water Solutions Forum (Water Forum) was a community-based, consensus-driven collaborative process. Water Forum stakeholders representing diverse entities, including business, conservation, recreation, local government, state agency and downstream interests worked together to create the Big Sky Area Sustainable Watershed Stewardship Plan. The Water Forum was convened to:

- Unify efforts to address water resources for the Big Sky area and surrounding zone of influence in three co-equal water resources focus areas:
 - Ecological Health of River Systems
 - Water Supply and Availability
 - Wastewater Treatment and Reuse
- Develop recommendations for solutions and actions to address current and future water needs for both the natural and human communities
- Support community implementation of the solutions

Three water resources focus areas were chosen after extensive stakeholder interviews and assessment.

These three co-equal water resources focus areas are:

1. **Ecological Health of River Systems:** High quality water resources are a critical part of keeping the fisheries, wildlife, scenic values and recreation-based economy healthy.
2. **Water Supply and Availability:** Limited physical and legal groundwater and surface water supply affects both the river systems and the people and businesses in the community who rely on water to meet their needs.
3. **Wastewater Treatment and Reuse:** Infrastructure to treat and effectively reuse reclaimed water ranges from advanced centralized treatment facilities to individual septic systems, and the needs of a growing community strain existing capacity.

1.1 STAKEHOLDER-DRIVEN PROCESS

Water Forum stakeholders represented agricultural, business, conservation, local government, agency, and recreation perspectives in the Big Sky area and downstream (**Figure 1-1** and **Table 1-1**). The Water Forum was convened in June of 2016, after an extensive community assessment process in the spring of 2016 (**Appendix A**). The Gallatin River Task Force (Task Force) hosted the Water Forum and an advisory committee guided the process. Participation as a stakeholder in the Water Forum was voluntary, and all stakeholders agreed to commit to engagement in the process and a set of ground rules. The Water Forum employed consensus-based decision-making. All stakeholder meetings were open to the public and members of the community participated throughout the process. The Water Forum held 13 meetings between June 2016 and November 2017. These were all three-hour meetings focused on information sharing, analysis and decision-making. Stakeholders presented background information in each of the three focus areas to establish a common understanding of water resources in the Big Sky area during the fall of 2016. Summaries of these presentations for each of the three water resources focus areas are provided in **Appendices B** through **D** and the presentations are available on the Task Force website at: <http://www.gallatinrivertaskforce.org/projects/big-sky-sustainable-water-solutions-forum/>. Throughout 2017, Water Forum stakeholders identified goals and objectives, evaluated alternatives, and identified preferred actions for the sustainable management of Big Sky area's water resources within each of the three focus areas.

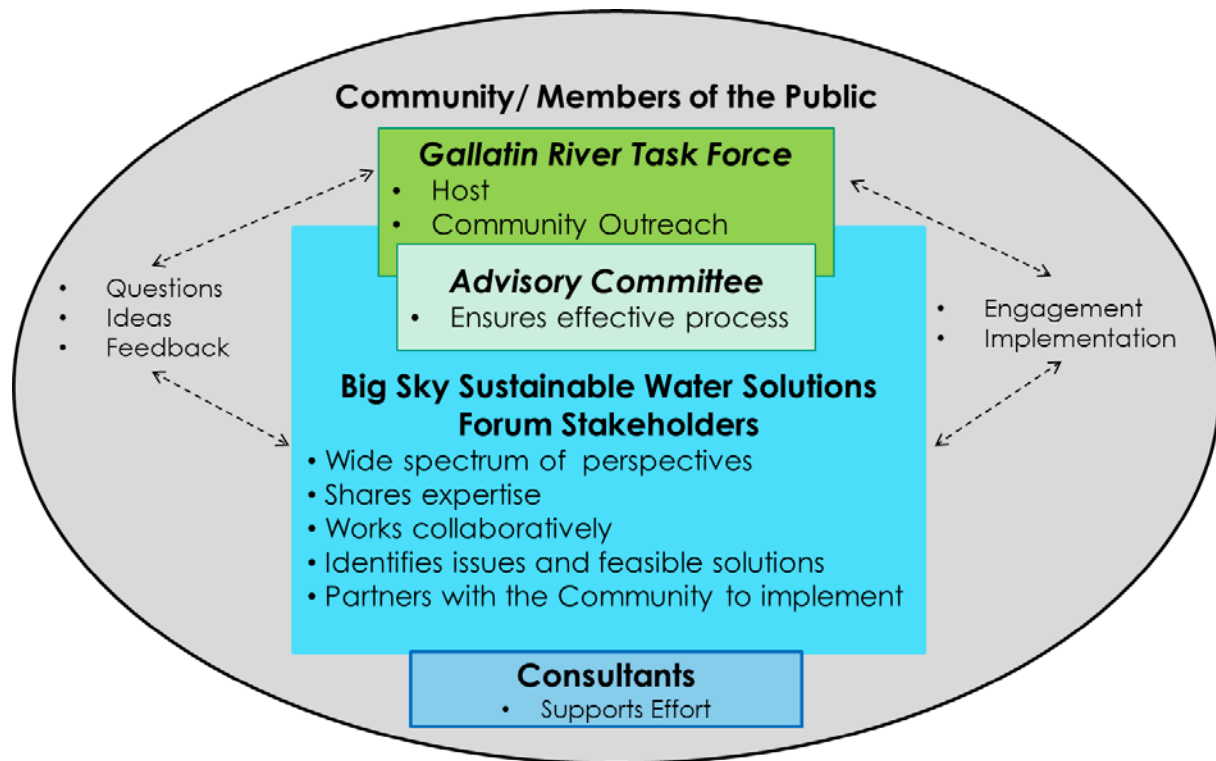


Figure 1-1. Big Sky Sustainable Water Solutions Forum Structure and Roles

Table 1-1. Big Sky Sustainable Water Solutions Forum Stakeholders

Stakeholders	Entities Represented
Guy Alsentzer	Upper Missouri Waterkeeper
Brad Bauer	Greater Gallatin Watershed Council
Eric Becker	Geyser Whitewater Expeditions
Scott Bosse	American Rivers
Pat Byorth	Trout Unlimited
Rich Chandler	Yellowstone Club, Gallatin River Task Force Board
Mike DuCuennois*	Yellowstone Club, Big Sky Sewer & Water District Board
Susan Duncan	Association of Gallatin Agricultural Irrigators
Ron Edwards*	Big Sky Sewer and Water District, Gallatin River Task Force Board
Kristin Gardner*	Gallatin River Task Force
Kevin Germain*	Lone Mountain Land Company, Big Sky Chamber of Commerce Board, Resort Tax Board
Jim Hart	Madison County Commissioner
Travis Horton	Fish, Wildlife and Parks, Region 3
Matt Kelley	Gallatin City-County Health Department
Proxies: Tom Moore Lori Christenson	
Ethan Kunard	Madison Conservation District, Madison County Planning Board
Peter Manka	Alpine Water
Taylor Middleton	Big Sky Resort
Dave Moser	Fish, Wildlife and Parks, Region 3
David O'Connor*	Buck's T-4 Lodge, Big Sky Chamber of Commerce Board
Mike Richter	Montana Bureau of Mines and Geology, Gallatin River Task Force Board
Technical Expert: James Rose	
Ann Schwend	Department of Natural Resources and Conservation - Helena Office
Suzan Scott	Big Sky Owner's Association
Bill Simkins	Big Sky Town Center
Tim Skop	Gallatin County Planning Department
Kerri Strasheim	Department of Natural Resources and Conservation - Regional Water Office
Tammy Swinney	Gallatin Local Water Quality District
Proxy: Torie Haraldson	
Eric Urban	Department of Environmental Quality
Wendi Urie	Custer-Gallatin National Forest
Darcie Warden	Greater Yellowstone Coalition
Brian Wheeler*	Big Sky Resort, Big Sky Sewer & Water District Board
Steve White	Gallatin County Commissioner
Jessie Wiese	Montana Land Reliance
Ennion Williams	Big Sky Trout, Big Sky Vacation Rentals
Ciara Wolfe	Big Sky Community Organization
Bob Zimmer*	Greater Yellowstone Coalition

*Advisory Committee Member

1.2 COMMUNITY ENGAGEMENT AND INPUT

All Water Forum stakeholder meetings were open to members of the public. Community engagement and input meetings were also conducted throughout the project area and zone of influence to share information, answer questions and listen to input. In all, 15 community meetings or presentations to organizations were conducted in addition to the 13 stakeholder meetings (**Table 1-2**).

Table 1-2. Community Meetings

Event or Organization	Location	Date
Community Town Hall Meeting	Big Sky	December 6, 2016
Big Sky Water & Sewer District Board	Big Sky	June 20, 2016
Gallatin Conservation District	Manhattan	August 17, 2017
Association of Gallatin Agricultural Irrigators	Manhattan	August 31, 2017
Big Sky Chamber of Commerce Board	Big Sky	September 12, 2017
Community Meeting	Belgrade	September 13, 2017
Community Meeting	Bozeman	September 18, 2017
Gallatin River Task Force Board	Big Sky	October 3, 2017
Madison Conservation District	Ennis	October 16, 2017
Rotary Club of Big Sky	Big Sky	October 18, 2017
Community Information on Wastewater (Panelists)	Bozeman	October 29, 2017
Madison Planning Board	Virginia City	October 30, 2017
Joint Madison-Gallatin Commissioner Meeting	Big Sky	November 1, 2017
Gallatin Local Water Quality District Board	Bozeman	December 7, 2017
Community Town Hall Meeting	Big Sky Chapel	January 31, 2018

In addition to the community meetings, a community survey was administered between August 3 and September 25, 2017 via an online link that was distributed on the Task Force website, stakeholder and public email lists, and the Explore Big Sky newspaper. The survey was designed to provide information on water resources activities and obtain input on draft priorities. A total of 137 people responded to the survey and the results are presented in **Appendix E**. A project website hosted by the Task Force was maintained throughout the process and included videos of stakeholder presentations and links to background documents provided by the stakeholders. In addition, periodic blog articles were written and posted on the Task Force website and distributed to their email, social media and mailing distribution list. These posts reflected the work of the stakeholders for the interested public. In addition, press releases were sent ahead of every community meeting and members of the press were invited to attend the stakeholder meetings.

1.3 GOALS AND OBJECTIVES FOR THREE WATER RESOURCES FOCUS AREAS

Overall Vision Statement

Big Sky strives to be a model mountain community by protecting and improving water resources, sustaining ecological health of the watersheds, and supporting a vibrant local economy.

The **goal** of the collaboration is to ensure that the ecological health of the headwater river system in the Big Sky area is maintained and to identify sustainable solutions for water supply and wastewater treatment.

Water Resources Focus Area: Ecological Health of the River Systems

Goal

A healthy and resilient river system sustained through a principled approach to watershed stewardship that includes human activities and natural processes that maintain and enhance stream, riparian and wetland conditions and connections, ensuring water remains clean and cold.

Objectives

- Maximize water quantity, protect existing high quality and improve degraded water quality
- Identify, sustain, and enhance high-value riparian corridors and wetland areas
- Sustaining aquatic communities while enhancing native fish populations

Water Resources Focus Area: Water Supply and Availability

Goal

Manage and balance surface and groundwater supplies for a vibrant community sustaining a broad spectrum of uses and values including fisheries, wildlife, recreation, agriculture, municipal and domestic needs.

Objectives

- Sustainably manage groundwater and surface water by improved monitoring and forecasting, conservation, and reuse of reclaimed water
- Maintain sufficient, high quality year-round instream flows to meet ecological needs (quality and quantity)
- Increase community resilience to drought and climate variability

Water Resources Focus Area: Wastewater Treatment and Reuse

Goal

Develop and implement holistic wastewater and stormwater management, utilizing best available technologies and practices, to meet Big Sky's long-term community needs and protect and improve the ecological health of the river systems.

Objectives

- Ensure wastewater does not have a negative impact on the ecological health of the river systems and groundwater resources
- Identify alternative strategies for land application of treated wastewater
- Address individual septic systems

Figure 1-2 depicts the three water resources focus areas and their interrelationships. Groundwater and surface water must supply enough water for the human and natural communities. Wastewater treatment and reuse needs to safeguard human health and protect the ecological health of the river systems. Maintaining and enhancing the health of streams, riparian areas, and wetlands supports vibrant fish and wildlife populations and preserves the scenic and recreational values that are the foundation of the Big Sky area's economy.

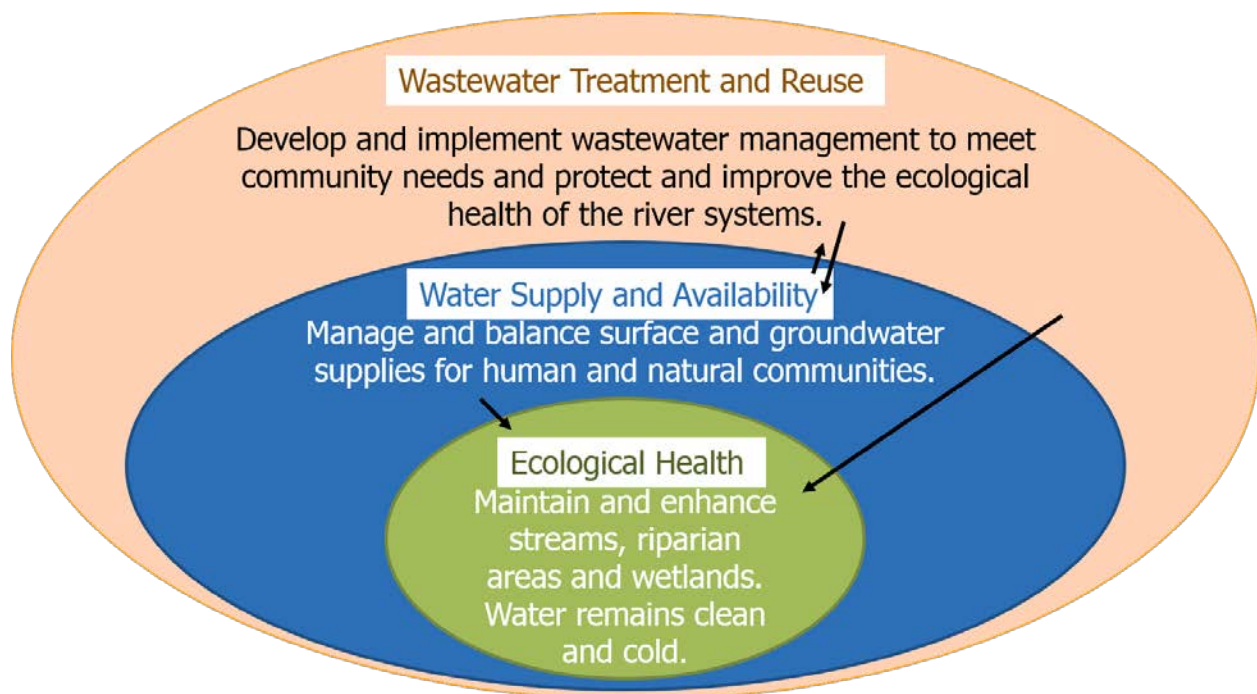


Figure 1-2. Big Sky Sustainable Water Solutions Forum Goals

1.4 CHALLENGES AND OPPORTUNITIES

Water resources challenges in the Big Sky area include:

- Cumulative impacts from past and current activities
 - Development
 - Visitation
 - Transportation
 - Logging
- Impairments to water quality in three streams
 - Middle Fork West Fork Gallatin River (nutrients, sediment, pathogens)
 - South Fork West Fork Gallatin River (nutrients, sediment)
 - West Fork Gallatin River (nutrients, sediment)
- Meeting current and future needs for water supply
 - Limited water supply
 - Closed basin with no new appropriations
 - Complex geology and annual recharge from snowpack
 - Summer water use is 7-8x winter water use
- Meeting current and future needs for wastewater treatment and reuse
 - Limited treatment capacity in centralized wastewater treatment plants
 - Limited storage capacity in existing infrastructure
 - Ponds at Big Sky County Water and Sewer District, Yellowstone Club, Spanish Peaks, and Moonlight Basin
 - Limited disposal capacity using golf course and community park irrigation method
 - Wastewater flows estimated to exceed golf course and community park irrigation capacity around 2022-2027
 - Extensive use of septic systems and small community systems
 - 1,000+ septic systems in Big Sky area
 - Relatively high nutrient loads in treated effluent and varying maintenance
 - Septage trucked to Gallatin Valley
- Climate variability and drought
 - Increasing temperatures
 - Changes in the amount and timing of precipitation
 - Greater proportion of precipitation as rain instead of snow
 - Earlier snowmelt and changes in runoff patterns
 - Lower streamflows in late-summer when temperatures are warmest
- Community interest and support
 - Limited community understanding of water resources
 - Second home owners, visitors, transient workforce
 - Residents and visitors are often more familiar with living in wetter climate regimes
- Fragmented political, management, and ownership boundaries
 - Two counties, two conservation districts, two watersheds, not incorporated
 - Extensive platting, planning and zoning already granted by both counties
 - Large public and private land holdings, as well as numerous individual developments and individual tracts of land

Water resources opportunities in the Big Sky area include:

- Environmental opportunities
 - Both Gallatin and Madison watersheds have areas of high quality water resources within the Big Sky area
 - Areas of high quality riparian and wetland habitat
 - Native westslope cutthroat trout still present in a portion of the Big Sky area
 - Wild trout fisheries thriving
 - Overall water quality is both clean and cold in the Madison River and Gallatin River
 - High elevation and generally north-facing trend to flow of the two watersheds offers natural resiliency to drought and climate variability
 - As a headwater community, have greater control over water resources management than downstream communities which are dependent on upstream water management
- Economic opportunities
 - Widespread recognition in business community (development, recreation, tourism) that economic well-being is dependent on high quality water resources
 - Economic development and revenue generation in the Big Sky area provides opportunities for fundraising and local expenditures on infrastructure, conservation and monitoring activities
 - Existing planned, platted and/or zoned land is still about 50% unbuilt, offering opportunities to develop in more sustainable ways
- Scientific and management assets
 - Existing data, while not complete, provides significant information to aid analysis and decision-making
 - Broad range of water resources expertise in Big Sky area and downstream communities
- Community interest and support
 - Strong interest in water and natural resources among engaged community members
 - Strong recreational focus can be used to build support for high quality water resources

1.5 EXPECTED OUTCOMES OF IMPLEMENTATION

Expected outcomes of implementing this watershed stewardship plan include benefits for the river systems and the life they support, as well as benefits for the Big Sky area community and its economy. The goals and objectives in **Section 1.3** outline the desired outcomes that the Water Forum stakeholders formulated through consensus. Priorities and actions outlined in **Section 3.0** outline more specific steps Water Forum stakeholders identified that will help the community meet these desired outcomes.

Within the three water resources focus areas, benefits for both the river systems and the community have been identified as follows:

Ecological Health of the River Systems

Ecological Outcomes:

- Preservation of existing high-quality stream, riparian and wetland resources
- Restoration of streams, riparian and wetland areas that have been degraded
- Preservation and enhancement of native and wild trout fisheries and aquatic life

- Improved understanding of existing conditions and water quality trends will provide the ability to successfully manage activities that affect the health of the river systems, riparian areas and wetlands

Community and Business Outcomes:

- Preserved and enhanced river recreation and amenity-based economy
- Enhanced community knowledge and interest in water resources and impacts from human activities

Water Supply and Availability

Ecological Outcomes:

- Improved ability to maximize thoughtful use of limited groundwater and surface water supplies
- “Slowing the flow” of water through the system enhances delivery of clean water at critical times for fish and other aquatic life
- Increased resiliency from drought and climate variability

Community and Business Outcomes:

- Improved ability to maximize the thoughtful use of limited groundwater and surface water supplies
- Reduced water footprint supports growing resident and visitor population while limiting the need for more fresh water resources use
- Preserved and enhanced river recreation and amenity-based economy

Wastewater Treatment and Reuse

Ecological Outcomes:

- Improved water quality by addressing existing impairments
- Prevents future impacts to river systems from wastewater reuse by improving treatment levels and developing reuse alternatives that provide ecological benefits
- “Slowing the flow” of water through the system enhances delivery of clean water at critical times for fish and other aquatic life
- Conserved valuable fresh water supply through increased beneficial reuse options

Community and Business Outcomes:

- Enhanced capacity to address the needs of a growing community with a range of wastewater treatment and reuse infrastructure
- Supports locally-important recreational ski and golf industry
- Conserves valuable fresh water supply through increased beneficial reuse options

1.6 PROJECT AREA BOUNDARIES

The Big Sky Area Sustainable Watershed Stewardship Plan addresses water resources issues in the Big Sky area, which includes the West Fork Gallatin River watershed, Jack Creek watershed, and Gallatin River mainstem and tributaries between the Corral and Karst (Highway 191 Mile Markers 42 through 55). Since the developed areas are not incorporated, the Big Sky Resort Area District boundary was established to characterize the Big Sky area for planning purposes. An associated zone of influence of the Madison and Gallatin watersheds was also identified as important since the entire area is linked through its water resources, transportation corridors, and economic base (**Figure 1-3**).

1.6.1 River Systems and Subwatersheds

River systems and subwatersheds in Big Sky area include the West Fork Gallatin River watershed, Jack Creek watershed, and Gallatin River mainstem and tributaries between the Corral (Highway 191 Mile Marker 42) and Karst (Highway 191 Mile Marker 55) (**Figure 1-4** and **Appendix F**).

1.6.1.1 West Fork Gallatin River Watershed

The West Fork Gallatin River begins at the confluence of the North Fork West Fork Gallatin River and Middle Fork West Fork Gallatin River, and includes the following tributaries:

- North Fork West Fork Gallatin River
- Middle Fork West Fork Gallatin River
 - Beehive Creek
 - “Moose Tracks” Creek
 - “Stony” Creek
- South Fork West Fork Gallatin River
 - Muddy Creek
 - Third Yellow Mule Creek
 - Second Yellow Mule Creek
 - First Yellow Mule Creek

1.6.1.2 Jack Creek Watershed

Jack Creek is the major tributary to the Madison River within the project area, though only the upper portion of the Jack Creek watershed is within the project area. Lone Creek is a tributary to Jack Creek. In addition, the headwater portions of the Cedar Creek and Indian Creek subwatersheds are also within the project area.

1.6.1.3 Gallatin River Mainstem and Tributaries

The project area includes the mainstem of the Gallatin River extending from the Corral downstream to Karst (Highway 191 Mile Markers 42 through 55). Major tributaries to the Gallatin River within the project area include:

- Porcupine Creek
- Portal Creek
- Moose Creek
- Beaver Creek
- West Fork Gallatin River
- Deer Creek

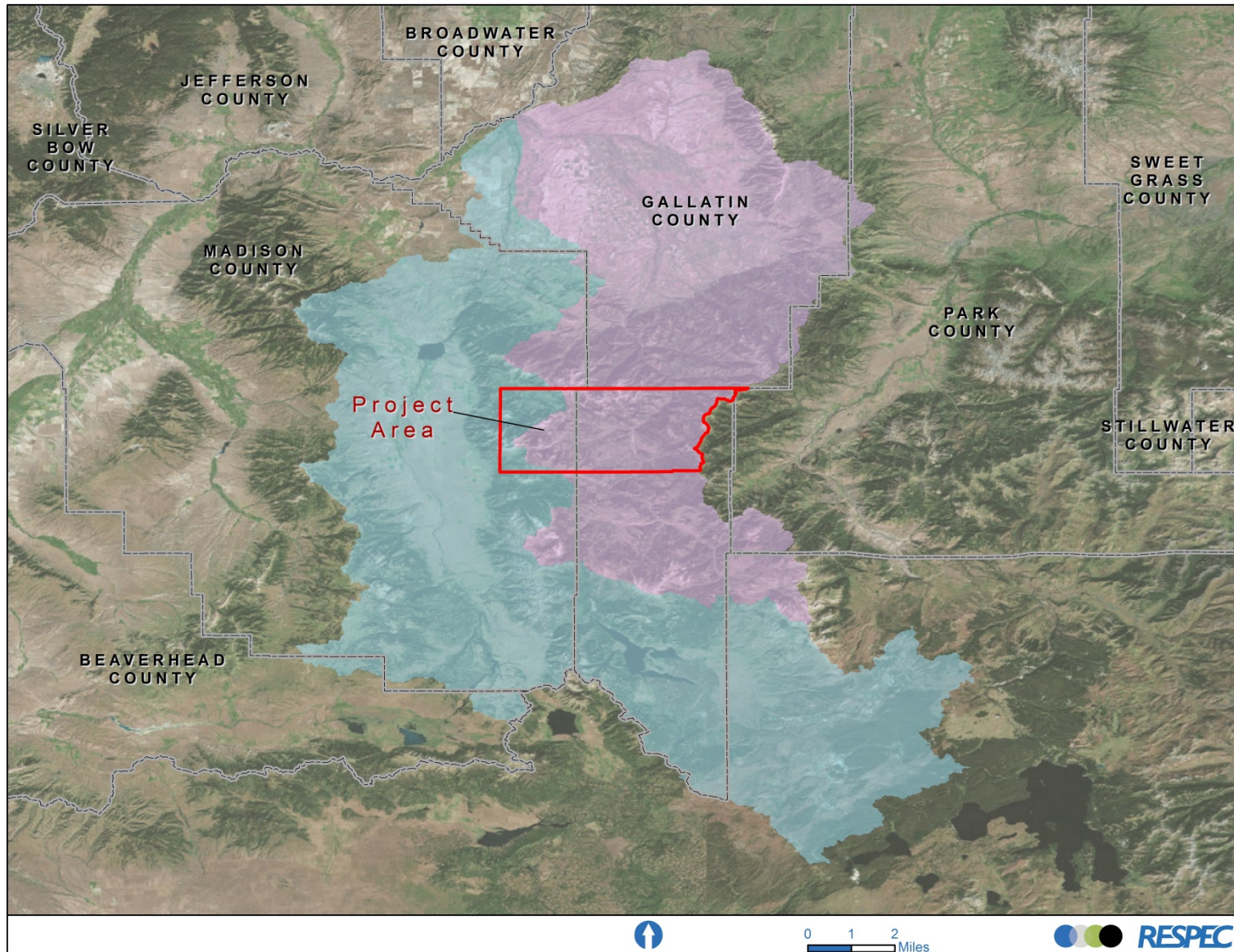


Figure 1-3. Project Area Location within the Gallatin and Madison Watersheds

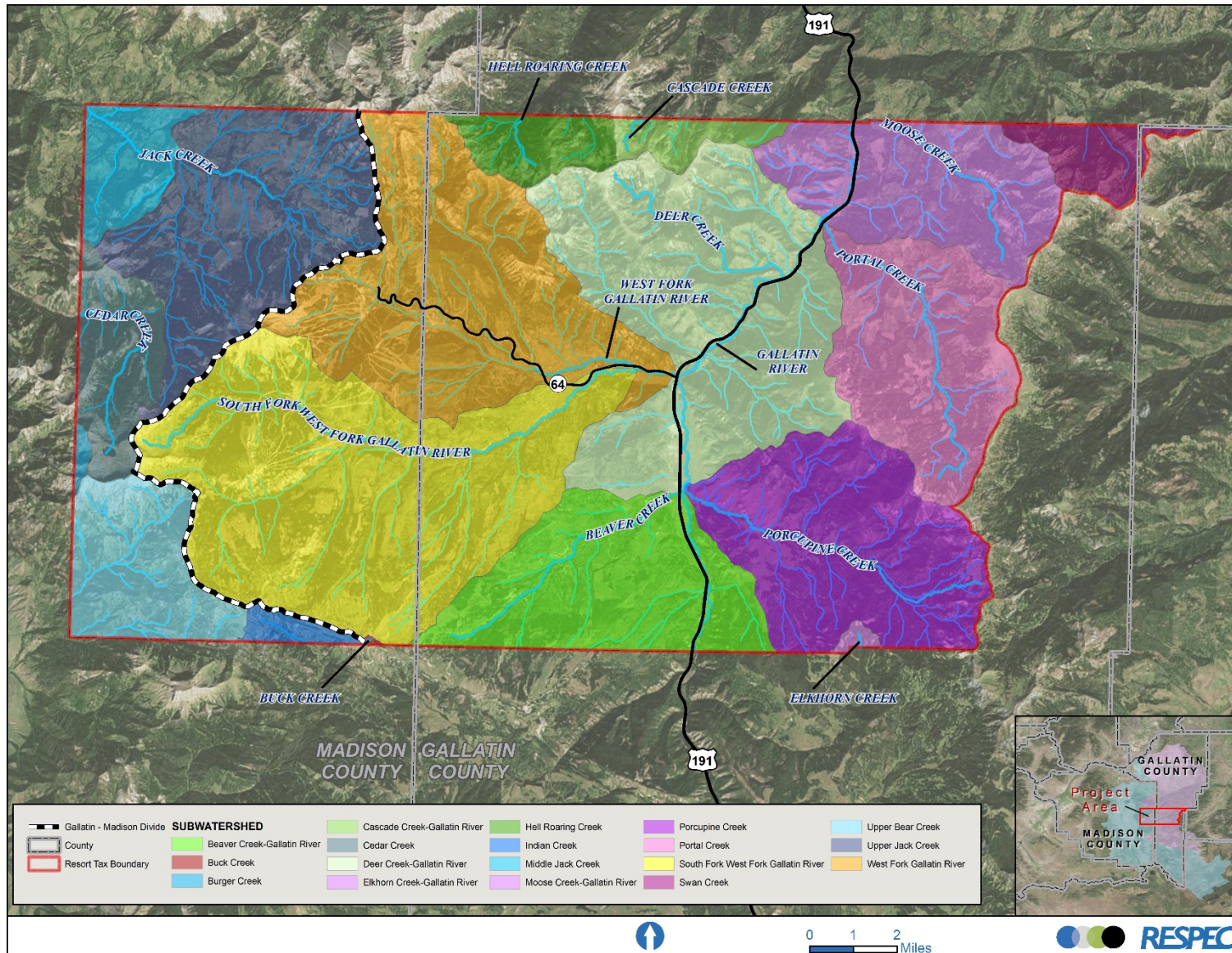


Figure 1-4. River Systems and Subwatersheds in the Big Sky Area

1.6.2 Ownership Boundaries and Demographics

The Big Sky area is fragmented politically since it is unincorporated and situated in two counties. There are several large land owners and land managers in the Big Sky area, including Big Sky Resort, Yellowstone Club, Lone Mountain Land Company, Town Center, U.S. Forest Service, and Montana Fish, Wildlife and Parks (FWP), along with numerous smaller developments and individual landowners (**Figure 1-5**). The water infrastructure of the Big Sky area is managed by multiple entities, with groundwater aquifers of varying productivity and quality providing water for personal homes, businesses and the ski resorts. Similarly, wastewater treatment and reuse are handled by multiple entities, ranging from advanced centralized treatment systems operated by Big Sky County Water and Sewer District (BSCWSD), Yellowstone Club, and Moonlight Basin to individual septic systems and small community systems.

1.6.2.1 Ownership and Water Infrastructure Service Areas

The Big Sky area has four distinct service areas for water supply and wastewater treatment, with different centers, infrastructure and management, including:

- Big Sky County Water and Sewer District (BSCWSD)
 - Big Sky Resort
 - Spanish Peaks
 - Town Center
- Yellowstone Mountain Club
- Moonlight Basin
- Gallatin Canyon (“Canyon” area) extending from the Corral to Karst

In addition to these major service areas, there are non-BSCWSD developments within the Meadow Village and outlying areas.

1.6.2.2 Demographics and Growth Projections

The Big Sky area has an estimated population of about 2,600 full-time residents based on the 2010-2014 U.S. Census. Population projections based on U.S. Census household data and projected growth rates estimates a future population of 4,500-14,000 residents in the Big Sky area, while a build-out study conducted in 2011 estimates approximately 7,400 residential units and places maximum future population as high as 16,000 (TischlerBise 2011). In addition to Big Sky area residents, much of the Big Sky workforce commutes, with approximately 1,900 commuters out of the 2,300 year-round workers (Kack 2016). A 2014 Community Profile stated that 15,000+ visitors per day are present during the peak of the ski season (Big Sky Chamber of Commerce 2014), while Resort tax revenue data and Chamber of Commerce visitor center data also indicate that summer-time visitation has been increasing. As growth continues, the level of occupancy by full-time and part-time residents will greatly affect water withdrawals and wastewater generation in the Big Sky area.

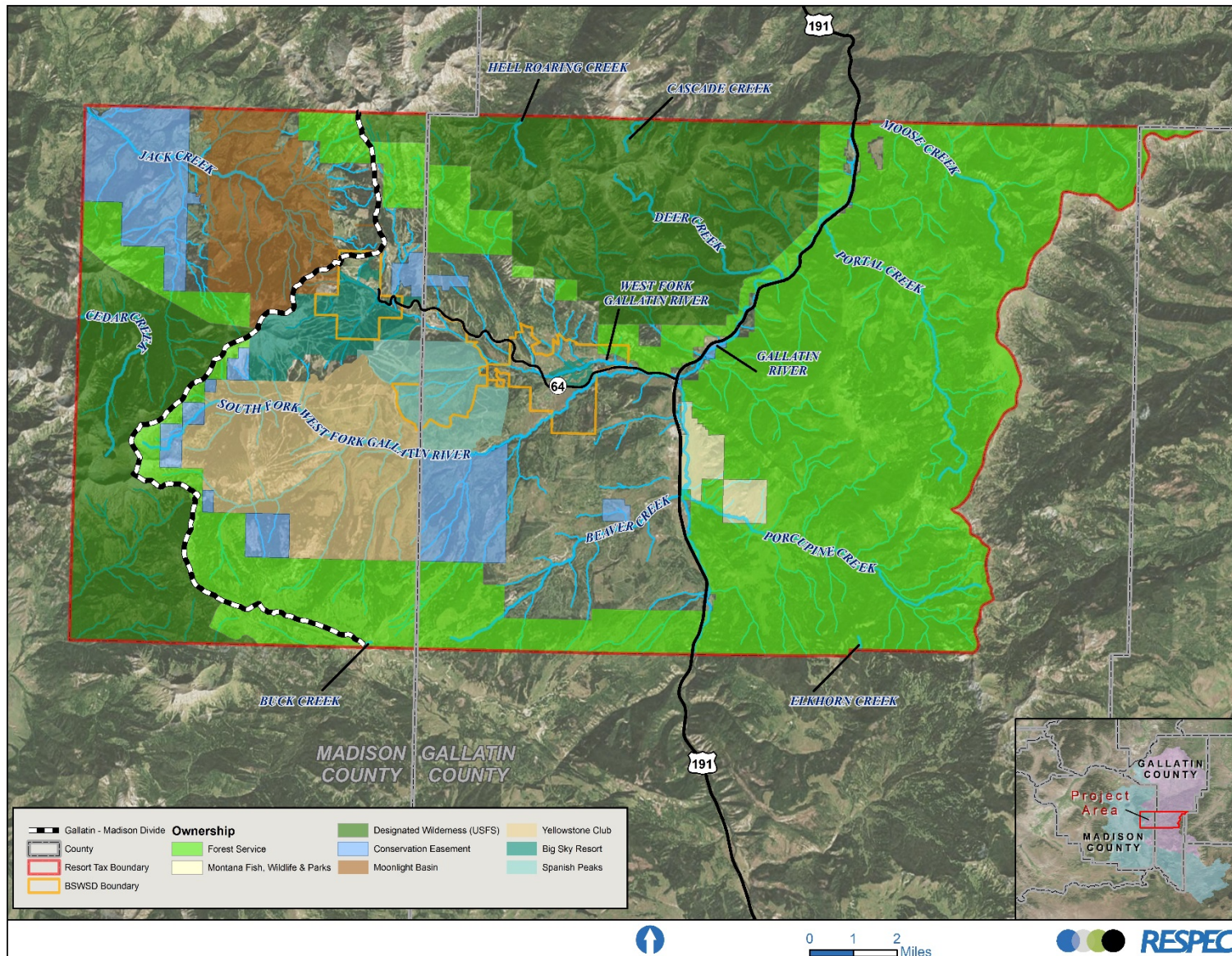


Figure 1-5. Ownership Boundaries in the Big Sky Area

2.0 ALTERNATIVES ANALYSIS FOR AREAS OF CONSENSUS

Through a series of meetings conducted between June of 2016 and November of 2017, Water Forum stakeholders discussed various alternatives within each of the three focus areas and arrived at several areas of consensus, which are presented in the following sections.

2.1 ECOLOGICAL HEALTH OF RIVER SYSTEMS

For **Ecological Health of River Systems**, the Water Forum stakeholder's reached consensus in three areas:

- 1) Watershed Status and Trends Monitoring Program
- 2) Watershed Status and Trend Dashboard
- 3) Watershed Restoration and Conservation

Water quality monitoring efforts in the Big Sky area have been led by the Task Force in the West Fork Gallatin River watershed since 2000 and by the Madison Conservation District (MCD) in the Jack Creek watershed since 2006. Within the West Fork Gallatin River watershed, the Task Force was the local liaison for the Total Maximum Daily Load (TMDL) water quality assessment conducted between 2005 and 2010, which resulted in three streams being identified as impaired by the Montana Department of Environmental Quality (DEQ), including (**Figure 2-2**):

- Middle Fork West Fork Gallatin River
 - Nitrate+nitrite (NO₃+NO₂)
 - Sediment
 - *E. coli*
- South Fork West Fork Gallatin River
 - Nitrate+nitrite (NO₃+NO₂)
 - Sediment
- West Fork Gallatin River
 - Nitrate+nitrite (NO₃+NO₂)
 - Total nitrogen (TN)
 - Sediment

For these three streams, the *West Fork Gallatin River Watershed Total Maximum Daily Loads (TMDLs) and Framework Watershed Water Quality Improvement Plan* (DEQ 2010) completed in 2010 identifies the maximum amount of a pollutant these water bodies can receive and still meet water quality standards. The West Fork Gallatin River Watershed TMDL document provides estimates of the percent reduction in pollutant loading that will be necessary for water quality standards to be met (**Table 2-1**). In addition to establishing TMDLs, the West Fork Gallatin River Watershed TMDL document includes an assessment of road densities, traction sand application, riparian buffer conditions, instream habitat conditions, and fish passage through culverts. Outside of the West Fork Gallatin River watershed, many streams have not been assessed and conditions are unknown. In 2012, the Task Force completed the *Upper Gallatin River Watershed Restoration Plan* (GRTF 2012), which provides a blueprint for improving water quality in impaired streams. Since 2012, the Task Force has been working to improve water quality, including:

- Conducting the Upper West Fork Gallatin River Nitrogen and Sediment Reduction project to reduce nitrogen and sediment inputs to the West Fork Gallatin River as it flows through the Big Sky Golf Course
- Hosting tailored educational workshops on strategies to reduce nitrogen and sediment loading for golf course managers, landscapers, realtors, horse owners, and builders
- Installation of educational signage and dog waste stations across the Big Sky community
- Development and dissemination of the following brochures: septic system maintenance, trout friendly landscaping, golf course irrigation and fertilizer management

Table 2-1. Pollutant Load Reductions Required to Meet Water Quality Standards

Stream Segment	Nitrate+ Nitrite	Total Nitrogen	<i>E. coli</i>	Sediment
Middle Fork West Fork Gallatin River	33%	n/a	55%	29%
South Fork West Fork Gallatin River	0%*	n/a	n/a	0%**
West Fork Gallatin River	33%	36%	n/a	0%**

*Current nitrate+nitrite load not calculated due to nutrient uptake concerns resulting from algal growth; total load allocations developed

**Current estimated sediment load is equal to the total allowable sediment load; percent sediment load reductions are required for roads, streambank erosion and upland erosion to meet the TMDL because of the addition of an explicit Margin of Safety and future source allocation

In addition to the TMDL assessments, ongoing water quality monitoring conducted by the Task Force has identified the following spatial trends:

- Nitrogen and chloride are elevated in the Middle Fork West Fork Gallatin River and West Fork Gallatin River
- Algae growth is elevated in the Middle Fork West Fork Gallatin River, South Fork West Fork Gallatin River, and West Fork Gallatin River

Seasonal trends identified by the Task Force indicate that:

- Chloride is highest pre-snowmelt
- Turbidity is highest during spring runoff
- Nitrate is highest in the winter
- *E. coli* is highest in the summer

Macroinvertebrate data collected by the Task Force confirms elevated nutrient concentrations and sediment levels in the Middle Fork West Fork Gallatin River and West Fork Gallatin River. In the summer, biological uptake by algae masks nitrogen concentrations, which complicates the evaluation of nutrient loads (Gardner et al. 2009, 2011). Recent research conducted by Montana State University (MSU) indicates there is a significant fluctuation of total nitrogen throughout a 24-hour cycle, with nitrogen concentrations lowest during the day when algae are photosynthesizing and using nitrogen (Storb 2016).

During the TMDL process, riparian buffer conditions were assessed using National Agricultural Imagery Program (NAIP) color imagery from 2005 for several streams in the West Fork Gallatin River watershed. Riparian areas were classified as healthy (good), moderately disturbed (fair), or heavily disturbed (poor). In addition, the recently completed *Gallatin Canyon River Access Site Assessment* (Dunn and Collins 2015) identified areas where riparian vegetation has been degraded along the Gallatin River due to recreational use, while also identifying sites where traction sand applied to Highway 191 has a direct pathway into the Gallatin River due to the lack of a riparian buffer. The primary public source of wetland and riparian information in the Big Sky area is the National Wetland Inventory (NWI) created by the U.S.

Fish and Wildlife Service, which provides geospatial information on wetland extent, type and change using remote sensing techniques. In addition, many wetlands in the Big Sky area have been mapped on-the-ground within areas where development is occurring, though this information is not currently publicly available.

Fisheries monitoring conducted by FWP on the mainstem Gallatin River above (Porcupine Section) and below (Jack Smith Section) the confluence of the West Fork Gallatin River indicates that rainbow trout populations double downstream of the confluence with the West Fork Gallatin River. Fisheries monitoring also indicates that rainbow trout populations have been increasing over the past 30 years. There is a significant amount of groundwater upwelling in the Gallatin River near the confluence with the West Fork Gallatin River, which provides increased streamflow and more stable temperatures. Mild nutrient enrichment contributed from the West Fork Gallatin River watershed may also play a role in increased rainbow trout densities downstream of the West Fork. Westslope cutthroat trout are still found in the upper Gallatin River watershed, including the upper South Fork West Fork Gallatin River watershed, the Gallatin River mainstem, and Porcupine Creek. While westslope cutthroat trout inhabit about 25% of the system, only 3% are considered non-hybridized and contain over 90% cutthroat genes.

Streamflow measurements are currently conducted by the Task Force at four monitoring sites in the West Fork Gallatin River watershed and by MCD at two sites in the Jack Creek watershed. During 2008, high flow measurements conducted in the West Fork Gallatin River indicated that this drainage contributed approximately 15% of the streamflow to the mainstem of the Gallatin River at peak flows during spring runoff when the Gallatin River was flowing at approximately 6,000 cubic feet per second (cfs) (**Figure 2-1**, Dunn 2009). In addition, streamflow monitoring on the Gallatin River mainstem conducted by the Montana Department of Natural Resources and Conservation (DNRC) in 2005-2007 indicated groundwater upwelling contributes an average of approximately 85 cfs to the Gallatin River mainstem within the vicinity of the West Fork Gallatin River confluence during August through November baseflow conditions.

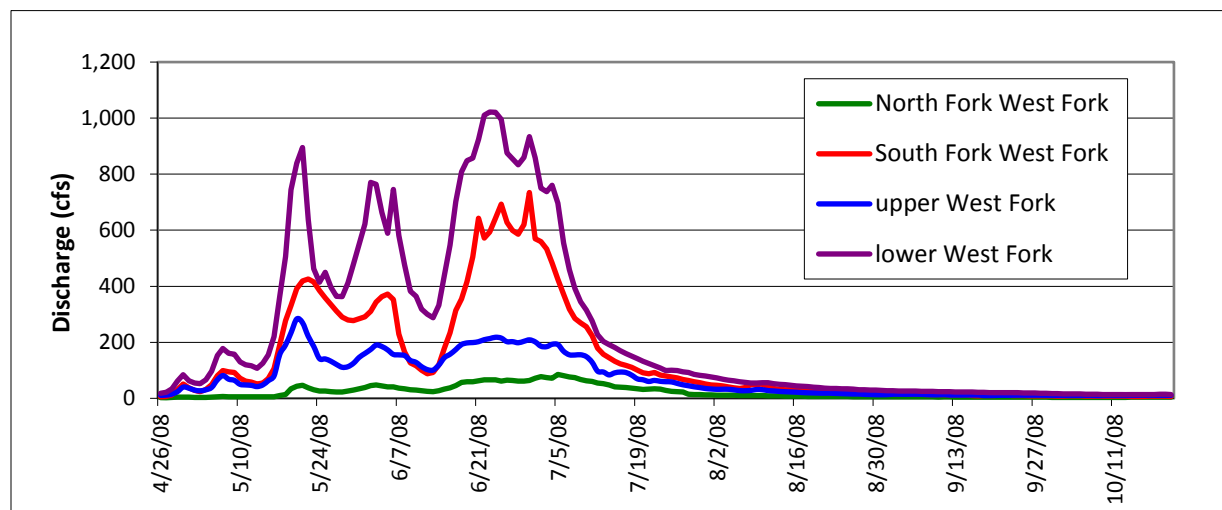


Figure 2-1. West Fork Gallatin River Watershed Mean Daily Streamflows, 2008

Additional background information on the Ecological Health of River Systems in the Big Sky area can be found in **Appendix B**, which provides a summary of stakeholder presentations at the August 31, 2016 Water Forum stakeholder meeting, including presentations from RESPEC, DEQ, Task Force, Montana Land Reliance (MLR), and American Rivers (AR).

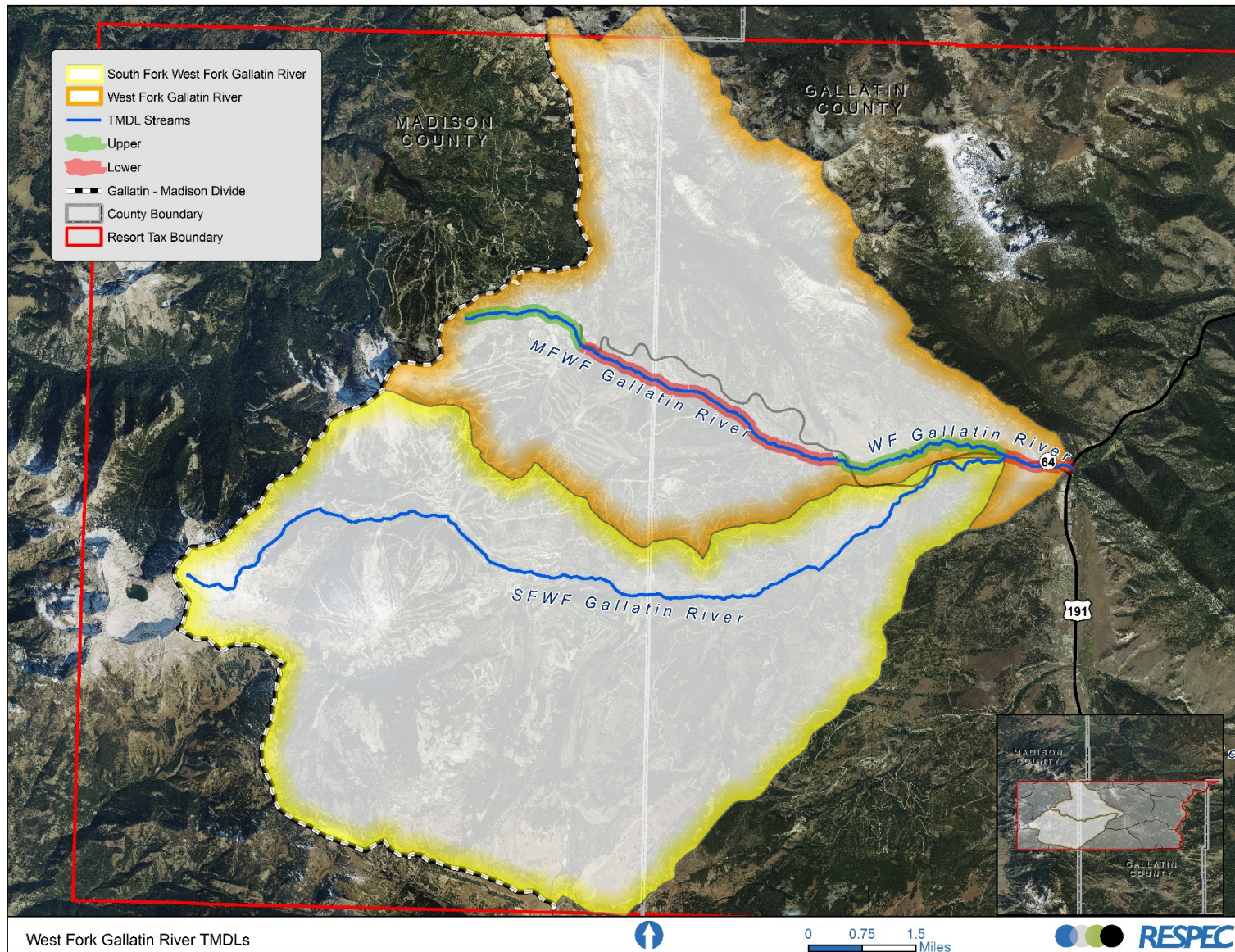


Figure 2-2. Impaired Stream Segments in the West Fork Gallatin River Watershed

2.1.1 Watershed Status and Trends Monitoring Program

The purpose of the **Watershed Status and Trends Monitoring Program** is to:

- Assess overall condition and trends of ecological resources using key environmental indicators
- Provide a feedback mechanism to support adaptive management and evaluate responses to management actions
- Provide a basis for reporting on the state of the watershed to stakeholders and the community

Technical considerations for establishing the Watershed Status and Trends Monitoring Program include ongoing monitoring, mapping and data collection of environmental parameters, which will include:

- Water quality
 - Total nitrogen and nitrate+nitrite
 - *E. coli*
 - Dissolved oxygen
 - Chloride
 - Pharmaceuticals
- Algal standing crops
- Streamflow (high flow, baseflow synoptic sampling, wetted perimeter at riffles)
- Water temperature
- Precipitation and snowpack
- Fish populations and macroinvertebrates
- Instream habitat, sediment transport and stream geomorphology
- Wetland and riparian habitat
- Aquatic invasive species

Monitoring, mapping and data collection of environmental parameters will focus on tributary streams most affected by development and potential changes to the aquifer, along with the Gallatin River mainstem. In addition, streams located outside of areas of development will be assessed to provide baseline water quality data, streamflow data, fisheries data, and information on natural channel and riparian processes. Within the Gallatin River watershed, the Watershed Status and Trends Monitoring Program will build on the water quality and streamflow monitoring network established by the Task Force and will be expanded to include wetland and riparian assessments, instream habitat assessments, and fish population monitoring, while also expanding existing water quality monitoring efforts to better characterize nutrient dynamics within the river systems. Within the Madison River watershed, MCD will continue the Madison Stream Team's monitoring in the Jack Creek watershed and will expand monitoring to include parameters assessed in the West Fork Gallatin River watershed so that a comprehensive dataset is developed for the entire Big Sky area. Data will be collected by professional scientists, agency staff, and volunteers, including local school students.

Since fishing and river-based recreation are major economic drivers, along with an important social component, within the Big Sky area, developing locally-based fish population data and instream habitat data to aid in the management of the fishery is a near-term priority, including information on native salmonid populations (westslope cutthroat trout and mountain whitefish), introduced salmonid populations (rainbow trout, brown trout, brook trout, and Yellowstone cutthroat trout), wetted perimeter requirements, fish passage barriers, and trout spawning habitat. Continuing and expanding

the collection of macroinvertebrate data will provide insights into long-term trends in water quality and instream habitat. In addition, tracking potential impacts of aquatic invasive species on wild and native trout populations will require ongoing efforts. Given the rapid rate of development, identifying key wetland and riparian habitats and their connectivity to groundwater and surface water is also a near-term priority. Identifying sediment transport capacities and geomorphic processes specific to streams in the West Fork Gallatin River and Jack Creek watersheds and along the Gallatin River is needed to evaluate expected sediment loads based on elevation, hydrology, gradient, geology, and geomorphology within the context of changing land-use practices and expanding development. Information collected through the Watershed Status and Trends Monitoring Program will provide a comprehensive understanding of watershed scale processes, track changes to water quality, fill data gaps, and provide a foundation for adaptive management.

Policies, Regulations and Laws relevant to the Watershed Status and Trends Monitoring Program include Sections 303d and 305b of the Clean Water Act, along with the Montana Water Quality Act, FWP instream flow reservations, and FWP Fish Management Plans.

Economics and Cost Considerations for the Watershed Status and Trends Monitoring Program include funding in the near-term to fill in identified data gaps, including:

- Water quality monitoring to better characterize nutrient dynamics within the river systems
- Wetland and riparian condition and connectivity with groundwater and surface water
- Wild and native fish population dynamics and fish passage barriers
- Instream habitat, sediment transport and stream geomorphology
- Headwater streamflows and gaining and losing stream reaches
- Gallatin River streamflows above and below the confluence with the West Fork Gallatin River
- Stormwater outfalls and sediment basins, followed by modeled stormwater flow
- Traction sand and road salt application
- Baseline pharmaceuticals

Addressing identified data gaps in the near-term is a funding priority, along with the identification and establishment of a long-term source of funding to sustain the Watershed Status and Trends Monitoring Program. The Gallatin Local Water Quality District (GLWQD) is currently developing a Surface Water Trend Monitoring Plan for a network of surface water monitoring sites within the GLWQD boundary, which includes the Big Sky area within Gallatin County. State and federal grants, community foundations, non-profit organizations, and other sources of public and private funding will be needed to sustain the Watershed Status and Trends Monitoring Program over the long-term.

Community Interest and Support for the Watershed Status and Trends Monitoring Program is strong since fishing and river-based recreation provide a centerpiece for the Big Sky area community and are a foundation of the recreation-based economy.

Potential Partner Organizations to implement the Watershed Status and Trends Monitoring Program include the Task Force, MCD, FWP, GLWQD, Montana Bureau of Mines and Geology (MBMG), DEQ, DNRC, Custer Gallatin National Forest (CGNF), United States Geological Survey (USGS), BSCWSD, Gallatin Conservation District (GCD), and MSU, among others.

2.1.2 Watershed Status and Trends Dashboard

The purpose of the **Watershed Status and Trends Dashboard** is to:

- Provide a user-friendly means of summarizing and conveying complex environmental monitoring results on watershed status and trends for the community
- Provide a community-oriented report card for evaluating the effectiveness of water resources management actions

The Watershed Status and Trends Dashboard will be developed and maintained to convey the information collected in the Watershed Status and Trends Monitoring Program to the community. The intent of the dashboard is to educate the community on stream conditions, aquifer conditions, snowpack, precipitation, drought resilience, wetland and riparian conditions, and fisheries so as to develop a high level of community awareness and engagement in the Big Sky area's streams, rivers and wetlands so the entire community can take pride in their local waterways and feel it's their responsibility to protect and preserve the headwaters of the Gallatin River and Madison River watersheds. Since contributions to water quality degradation are typically diffuse and cumulative, response requires an educated and engaged community. The dashboard will provide a mechanism for accountability and transparency about river system health and progress towards meeting the goals of this watershed stewardship plan.

Technical considerations for Watershed Status and Trends Dashboard include data collection by the Watershed Status and Trends Monitoring Program, along with data analysis, reporting, and development of environmental "targets" or "triggers" that are specific and relevant to the streams of the Big Sky area, including the West Fork Gallatin River watershed, the Jack Creek watershed, and the Gallatin River mainstem. Determining desired conditions relative to ecological reference conditions and potential conditions given historic land use-practices and existing land-use activities within the Big Sky area will be based on science with input from the Task Force, MCD and researchers at MSU, along with county, state and federal agencies. Monitoring parameters included in the dashboard will build on the existing monitoring data collected by the Task Force and MCD in the Big Sky area and will include:

- Surface water quality
- Streamflow
- Instream habitat conditions
- Fisheries and aquatic communities
- Riparian buffer conditions
- Wetland conditions

Within the dashboard, monitoring parameters will be evaluated for specific environmental indicators, that will be grouped by index, environmental indicators, and monitoring parameters, as follows:

- Index = Priority topics expressed in the goals for the ecological health of the river systems
- Environmental Indicators = Measureable attributes related to goals that are feasible to monitor
- Monitoring Parameter = Specific item tracked to characterize changes in the environmental indicators

A conceptual diagram of the Watershed Status and Trends Dashboard is presented in **Table 2-2** and an example of how the dashboard will be used as a communication tool is presented in **Table 2-3**.

Color coded ratings will depict environmental conditions on the Watershed Status and Trends Dashboard and arrows will be used to show if conditions are trending upward towards improvement or downward towards poor condition as follows:

- Green = Good
- Yellow = Fair
- Red = Poor

Through the use of easily understandable environmental indicators, in combination with scientifically-based monitoring parameters, the Watershed Status and Trends Dashboard will provide a communication tool to educate the community, define desired outcomes, and show progress towards goals so that water resources managers can remain responsible to the community for watershed stewardship. The Watershed Status and Trends Dashboard will provide the necessary information to individuals and organizations responsible for managing water resources so that timely and appropriate water management decisions can be made.

Policies, Regulations and Laws relevant to the Watershed Status and Trends Monitoring Dashboard are the same as those described for the Watershed Status and Trends Monitoring Program, including Sections 303d and 305b of the Clean Water Act, along with the Montana Water Quality Act, FWP instream flow reservations, and FWP Fish Management Plans. The intent of the Watershed Status and Trends Dashboard is to identify “target” or “trigger” levels in which action is taken, along with a set of recommended actions, which could be voluntary or regulatory and based on commitments from water resources managers. Montana’s water quality standards, information in the West Fork Gallatin River Watershed TMDL document, guidance from FWP, and scientific research will provide the foundation for the “target” or “trigger” values. It is the expressed intent of the Water Forum’s stakeholders that the community of Big Sky, which is situated at the headwaters of the Gallatin River and Madison River watersheds, adopts local “target” or “trigger” levels that exceed water quality standards established by DEQ and which reflect the community’s commitment to high quality water resources and to be a good neighbor to downstream water users and communities.

Economics and Cost Considerations for the Watershed Status and Trends Monitoring Dashboard include funding in the near-term to finalize monitoring parameters, identify appropriate “target” or “trigger” values, and select appropriate data collection and assessment methodologies, which will be presented in a Sampling and Analysis Plan (SAP) and Quality Assurance Project Plan (QAPP) developed under the Watershed Status and Trends Program. Funding in the near-term is required to develop the Watershed Status and Trends Monitoring Dashboard, which is envisioned to be both electronically available, as well as a physical structure similar to the U.S. Forest Service Fire Danger signs. Over the long-term, funding will be required to sustain education, outreach and community engagement.

Community Interest and Support for the Watershed Status and Trends Monitoring Dashboard is strong since fishing and river-based recreation provide a centerpiece for the Big Sky area community and are a foundation of the recreation-based economy. The Watershed Status and Trends Dashboard will be accompanied by a set of recommended actions, which will require community support and engagement to be effective. Given the seasonal nature of many of the residents, workers and visitors to the Big Sky area, along with changing land ownership and land management, a communication plan and continual education and outreach efforts will be necessary to ensure that monitoring activities conducted by the Watershed Status and Trends Monitoring Program and conveyed in the Watershed Status and Trends Monitoring Dashboard effectively engage the Big Sky area community.

Potential Partner Organizations to implement the Watershed Status and Trends Monitoring Dashboard include the Task Force, MCD, FWP, GLWQD, MBMG, DEQ, DNRC, CGNF, USGS, BSCWSD, GCD, and MSU, among others. Real time data currently collected by federal agencies include streamflow (USGS), snowpack and precipitation (Natural Resource Conservation Service, NRCS), and long-range weather forecasts provided by the National Oceanic and Atmospheric Administration (NOAA) Climate Prediction Center will provide a starting point.

Table 2-2. Conceptual Watershed Status and Trends Dashboard

Index	Environmental Indicator	Monitoring Parameter
Streams and Rivers	Surface Water Quality	Total Nitrogen
		Nitrate + Nitrite
		Algal Standing Crops
		<i>E. coli</i>
		Chloride
	Streamflow	Bankfull Flows
		Baseflows
	Instream Habitat Conditions	Width/Depth Ratios
		Fine Sediment Accumulation
		Residual Pool Depth
		Pools/Mile
	Aquatic Communities	Large Woody Debris/Mile
		Fish/Mile
Fish Species Composition		
Fish Passage Barriers		
Mountain MMI		
Riparian Areas and Wetlands	Riparian Buffer Conditions	Observed/Expected (O/E)
		Riparian Buffer Width
	Wetland Conditions	Understory Shrub Cover
		Acres
		Function

Table 2-3. Conceptual Watershed Status and Trends Dashboard with Condition Rating*

Index	Environmental Indicator	Monitoring Parameter
Streams and Rivers	Surface Water Quality	Total Nitrogen
		Nitrate + Nitrite
		Algal Standing Crops
		<i>E. coli</i>
		Chloride
	Streamflow	Temperature
		Bankfull Flows
	Instream Habitat Conditions	Baseflows
		Width/Depth Ratios
		Fine Sediment Accumulation
		Residual Pool Depth
	Aquatic Communities	Pools/Mile
		Large Woody Debris/Mile
Fish/Mile		
Fish Species Composition		
Fish Passage Barriers		
Riparian Areas and Wetlands	Riparian Buffer Conditions	Mountain MMI
		Observed/Expected (O/E)
	Wetland Conditions	Riparian Buffer Width
		Understory Shrub Cover
		Acres
	Function	

*Ratings presented as an example and are not representative of actual conditions

As the Watershed Status and Trends Dashboard is developed and is embraced by the Big Sky area community, additional measures regarding water supply and wastewater treatment will also be added. Additional monitoring parameters to include in Watershed Status and Trends Dashboard to evaluate **Water Supply and Availability** include the number of wells, capacity of wells, well water levels, groundwater rights, groundwater nitrate concentrations, annual water yield, baseflows, surface water rights, number of Single Family Equivalents (SFEs), acres of lawn, and annual precipitation. The Watershed Status and Trends Dashboard for Water Supply and Availability will include environmental indicators for:

- Groundwater quality
- Groundwater quantity
- Surface water quality
- Surface water quantity
- Household water use
- Irrigation water use
- Precipitation

Additional monitoring parameters to include in Watershed Status and Trends Dashboard to evaluate **Wastewater Treatment and Reuse** include priority pollutants, whole effluent toxicity, population served, nutrient loading, transmissivity, evapotranspiration, number of septic systems, and septic condition. The Watershed Status and Trends Dashboard for Wastewater Treatment and Reuse will include environmental indicators for:

- Treated wastewater quality
- Treated wastewater volume
- Treated wastewater reuse
- Groundwater quality

Potential environmental indicators and monitoring parameters for Water Supply and Availability and for Wastewater Treatment and Reuse to be included in the Watershed Status and Trends Dashboard are presented in **Appendix G**.

2.1.3 Watershed Restoration and Conservation

The purpose of **Watershed Restoration and Conservation** is to:

- Restore watershed condition by addressing existing water quality impairments
- Establish a high-quality baseline condition to support future evaluations
- Demonstrate the Big Sky area community’s ability to address current water quality impairments and to maintain those improvements into the future
- Protect and enhance existing high-quality water resources

Watershed Restoration and Conservation include activities that restore degraded water resources and conserve high quality water resources.

Technical considerations for Watershed Restoration are focused on addressing existing water quality impairments and improving degraded water quality. Specifically, the Middle Fork West Fork Gallatin River, South Fork West Fork Gallatin River, and West Fork Gallatin River have been identified as impaired by DEQ and TMDLs have been developed for sediment, nitrate+nitrite, total nitrogen and *E. coli* (**Table 2-1** and **Figure 2-2** in **Section 2.1**). Addressing existing sediment, nutrient and pathogen loading to these streams is a near-term priority. Other streams within the Big Sky area may also have degraded water quality, but sufficient data has not been collected to assess their condition. Thus, obtaining the necessary information to evaluate existing conditions on un-assessed streams is a near-term priority, with data collection to fill these data gaps being a component of the Watershed Status and Trends Monitoring Program. In addition to water quality improvements, enhancing native fish populations is a priority and activities include removal of fish passage barriers, removal of non-native fish where appropriate, and restocking with nearest-neighbor “pure” native fish. Determining the existing presence and abundance of native fish is a near-term priority and a component of the Watershed Status and Trends Monitoring Program. Fish population monitoring by FWP and CGNF fisheries biologists will be a critical component in the evaluation and enhancement of native fish populations. Expanding fisheries monitoring to additional sites and increasing the frequency will be beneficial. For years and locations that FWP and CGNF fisheries biologists are unable to conduct fish population monitoring, additional monitoring using snorkel surveys will be beneficial and can be conducted by the Task Force and MCD with assistance from local volunteers and students.

Technical considerations for Watershed Conservation are focused on preventing additional water quality degradation, preventing additional streams from being designated as impaired by DEQ and limiting development in ecologically sensitive areas. Conservation of high value riparian corridors and wetland resources is a key component to maintaining hydrologic connectivity, instream habitat, and water quality in the Big Sky area. To identify the existing high value riparian corridors and wetland resources, riparian and wetland mapping and on-the-ground assessments are a near-term priority. Conserving wild fish populations and aquatic communities is emphasized since the fishery provides both recreational opportunities for Big Sky area residents and is a significant component of the recreation-based economy. Monitoring the biological component of streams, including fish populations and macroinvertebrates, will be a long-term component of the Watershed Status and Trends Monitoring Program and a primary message to be conveyed through the Watershed Status and Trends Dashboard. The development of “green” infrastructure to manage non-point source runoff and stormwater, both during construction and post-construction, will also be an important component for long-term watershed conservation.

Challenges facing restoration and conservation of high quality water resources and fisheries in the Big Sky area include:

- Rapid rate of development, increasing tourism and recreational pressure
- Climate variability and drought
- Extensive amounts of private land and absentee landowner management of lands
- Workforce that doesn't reside in the community
- Aquatic invasive species and ponds stocked with non-native fish
- Conversion of wild land to residential lawns

Proactively addressing the cumulative impacts of resort development, while maintaining natural ecological processes and disturbance regimes, will result in:

- Enhanced stream, riparian, wetland, and groundwater conditions and connections
- Clean and cold surface water resources
- Resiliency for changing climate conditions
- High quality river-based recreational activities

Policies, Regulations and Laws relevant to Watershed Restoration and Conservation include Sections 303d and 305b of the Clean Water Act, Montana Water Quality Act, FWP instream flow reservations, FWP Fish Management Plans, County zoning and "setback" regulations, Wild and Scenic River designation, tax codes relevant to conservation easements, State regulations for property management, and permitting requirements for construction activities along streams and wetlands. Federal land management policies also affect the Big Sky area since much of the land is located within the CGNF.

Economics and Cost Considerations for Watershed Restoration and Conservation include funding from local, county, state, and federal entities, along with community foundations, non-profit organizations, and other sources of public and private funding. Specific grant programs include DEQ 319 grants, FWP Future Fisheries grants, and DNRC Reclamation and Development Grants and Renewable Resource Grants and Loans. Economic challenges include the high cost of land for conservation, competitive grant programs at the State level, and grant programs that typically focus on project implementation, but not on the initial stages of project development or follow-up monitoring post-project construction.

Community Interest and Support is strong for Watershed Restoration and Conservation in the Big Sky area since rivers provide a centerpiece for the community and are a major economic driver. Restoration and conservation will depend on partnerships between water resources managers, developers, private landowners, public land managers, non-profit organizations, and interested citizens. There is an unknown level of support for changes in county-level regulations, such as stream setback requirements for construction. The Big Sky area's location within two counties will require high degree of coordination to effectively implement regulations that encourage conservation. With many stream segments and wetlands located on private lands, working with interested landowners will be essential.

Potential Partner Organizations to implement Watershed Restoration and Conservation include the Task Force, MCD, DEQ, FWP DNRC, CGNF, Big Sky Owners Association (BSOA), Big Sky Community Organization (BSCO), MLR, AR, The Nature Conservancy (TNC), Greater Yellowstone Coalition (GYC), Trout Unlimited (TU), and Upper Missouri Waterkeeper (UMW), along with the large-scale developments at Yellowstone Club, Spanish Peaks, Big Sky Resort, Moonlight Basin and Town Center.

2.2 WATER SUPPLY AND AVAILABILITY

For **Water Supply and Availability**, the Water Forum stakeholder’s reached consensus in five areas:

- 1) Groundwater Monitoring and Modeling
- 2) Strategies for Water Conservation
- 3) Stormwater Management
- 4) Wastewater Reuse
- 5) Mitigation of Water Rights

Groundwater in the Big Sky area is recharged annually by winter snowpack and large rain events and currently provides a sufficient water supply, though supplies may not be extensive enough to meet projected future needs without innovative water resources management. The primary water supply source in the Big Sky area is groundwater obtained from wells operated by BSCWSD, Yellowstone Club, and Spanish Peaks in the West Fork Gallatin River watershed and Moonlight Basin in the Jack Creek watershed (**Table 2-4**). The Meadow Village aquifer located under the Big Sky Golf Course is the primary source of water for the BSCWSD and includes five wells located to the north of the West Fork Gallatin River (**Figure 2-3**). Within the BSCWSD boundary, the recently completed *Water System Source Capacity Plan Update* (Cuanne 2015) identifies opportunities for maximizing capacity from existing wells and constructing new sources. Outside of the BSCWSD boundary, numerous individual wells provide water for small community systems, homes and businesses. There are several geologic formations from which groundwater is drawn in the Big Sky area, including sand and gravel aquifers, sandstone and shale aquifers, Madison limestone aquifers, and fractured bedrock aquifers. Sand and gravel aquifers and fractured bedrock aquifers, in which the BSCWSD water supply wells are located, provide high quality water, while sandstone and shale aquifers, in which many private wells in the Big Sky area are located, often provide lower quality water. In general, the Big Sky area water supply is high in calcium, which results in “lime scale” that is often treated by individual home owners using water softeners that add salt to the water.

Table 2-4. Groundwater Supply Wells in the Big Sky Area

Entity	Number of Wells	Water Supply (Gallons per Minute)	Water Supply (Million Gallons per Year)	Water Right Date Range
BSCWSD - Mountain Village	9	1,155	135.8	1971-2002
BSCWSD - Meadow Village	5	995	138.5	
Spanish Peaks	4	670	52.8	2004-2010
Yellowstone Club	13	592	63.1	2001-2014
Moonlight Basin	3	260	19.6	1968-2014
Total	34	3,672	409.8	

The Upper Missouri River basin and Jefferson and Madison basin are closed basins, which means there is no more water legally available for appropriation. In addition, groundwater is considered connected to surface water by DNRC and the development of new water sources will require mitigation for any water that is consumed. Mitigation water is available when water is no longer needed for its original purpose and can be obtained by purchasing or leasing historical water rights, with pre-1890 irrigation claims typically providing the most water for mitigation. However, mitigation is challenging in the Big Sky area since there are relatively few irrigation water rights available for conversion. Relative to instream flows,

FWP holds Murphy Rights on the mainstem of the Gallatin River with a priority date of 1970 (**Table 2-5**). In addition, FWP has instream flow reservations on several streams in the Big Sky area that were calculated based on the wetted perimeter method, which targets riffles at minimum flows to maintain aeration. The FWP instream flow reservations provide an indicator of the minimum flows required to maintain fish populations.

Table 2-5. Montana Fish, Wildlife and Parks Murphy Rights and Instream Flow Water Reservations

Stream	Reach	Date Range	Amount (cfs)
Murphy Rights			
West Gallatin River	Yellowstone Park to Gallatin Gateway	5/16-7/15	800
		7/16-5/15	400
Instream Flow Water Reservations			
Gallatin River #1	YNP boundary to West Fork Gallatin River	Jan 1-Dec 31	170
Gallatin River #2	West Fork Gallatin River to East Gallatin River	Jan 1-Dec 31	400
Middle Fork West Fork Gallatin River	Headwaters to North Fork West Fork Gallatin River	Jan 1-Dec 31	3
South Fork West Fork Gallatin River	Headwaters to mouth	Jan 1-Dec 31	5
West Fork Gallatin River	Middle and North fork confluences to mouth	Jan 1-Dec 31	26
Porcupine Creek	North Fork Porcupine Creek to mouth	Jan 1-Dec 31	4.5
Jack Creek	Lone Creek to mouth	Jan 1-Dec 31	24

Established monitoring of annual water production in the Big Sky area includes groundwater monitoring conducted by MBMG, BSCWSD, and GLWQD, along with streamflow measurements conducted by the Task Force at four monitoring sites in the West Fork Gallatin River watershed and by MCD at two sites in the Jack Creek watershed. In addition, the USGS operates streamflow gaging stations on the Gallatin and Madison rivers. Annual precipitation data is collected at the NRCS Lone Mountain Snow Telemetry (SNOTEL) site, the Western Regional Climate Center (WRCC) Big Sky 3 S (COOP) site, and by area ski resorts. The Lone Mountain SNOTEL site has recorded variable precipitation over the 1992-2015 timeframe (annual precipitation range: 26.2" to 42.9"; average of 33.7"), with increasing temperatures observed over this timeframe (average air temperature range: 31°F to 38°F; average of 38°F in 2015).

The recently completed *2017 Montana Climate Assessment* (Witlock et al. 2017) predicts warming temperatures, increased precipitation in the winter, spring and fall, decreased precipitation in the summer, and increased year-to-year variability in precipitation. With increasing levels of development and predicted changes to precipitation and runoff patterns, opportunities to enhance the management and reuse of the available water supply in the Big Sky area include monitoring and modeling, water conservation practices, innovative use of stormwater and wastewater, and water mitigation techniques. Groundwater Monitoring and Modeling, Strategies for Water Conservation, Stormwater Management, and Mitigation of Water Rights are discussed in the following sections, while wastewater reuse benefits for water supply, including Expanding Water Reuse for Irrigation, Developing Water Reuse for Snowmaking, and Investigating Shallow Groundwater Recharge are discussed in **Sections 2.3.3** through **2.3.5**. Additional background information on Water Supply and Availability in the Big Sky area can be found in **Appendix C**, which provides a summary of stakeholder presentations at the September 28, 2016 Water Forum stakeholder meeting, including presentations from RESPEC, DNRC, TU, MBMG and Alpine Water.

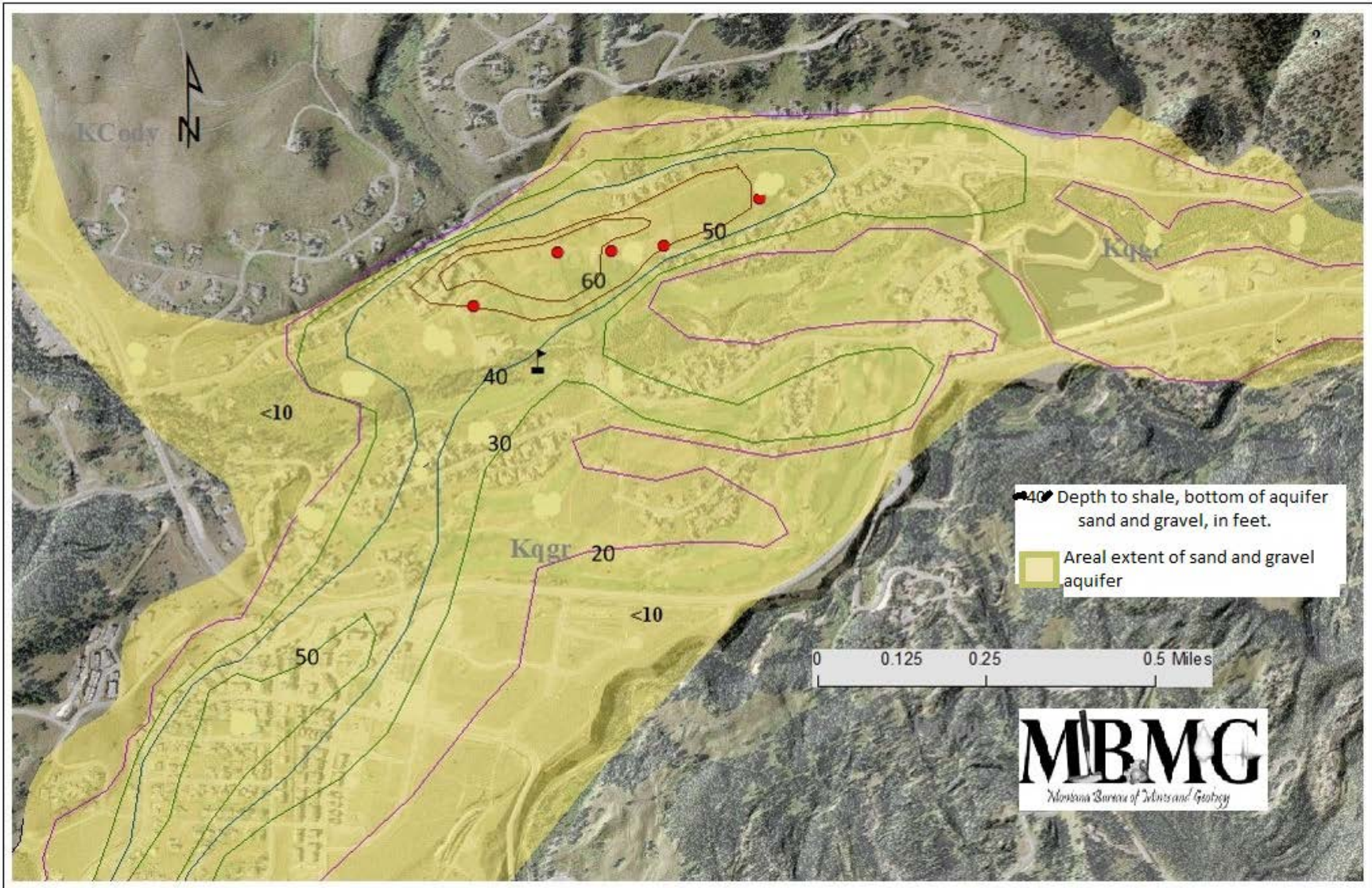


Figure 2-3. Meadow Village Aquifer Depths (Provisional Data Subject to Revision - Courtesy Montana Bureau of Mines and Geology)

2.2.1 Groundwater Monitoring and Modeling

The purpose of **Groundwater Monitoring and Modeling** in the Big Sky area is to:

- Accurately characterize the available water supply by generating seasonal outlook reports for groundwater supplies, modeling the impacts of various climate scenarios, modeling various withdrawal (pumping) amounts, developing real-time data on groundwater and surface water, and developing a water balance to identify “targets” or “triggers” for action
- Provide the necessary information to conserve and protect existing high-quality water supplies in the Meadow Village aquifer and other locally important aquifers as the first component of a comprehensive water conservation and management strategy

The Meadow Village sand and gravel aquifer, along with the sand and gravel and bedrock aquifers in the Mountain Village, provides the drinking water source for the BSCWSD. Outside of the BSCWSD boundary, numerous community and private wells provide drinking water. There is a sand and gravel aquifer associated with the Gallatin River as it flows through the Gallatin Wildlife Management Area downstream of the Porcupine Creek and Beaver Creek confluences. This area is identified as the Lower Basin on USGS topographic maps and is referred to locally as the “Canyon” area. These sand and gravel aquifers are recharged annually from snowpack and large rain events and there are extensive interactions between the groundwater in the aquifer and surface water in the river. Ongoing monitoring and modeling of these aquifers is a critical component for understanding and protecting groundwater supplies, while also maintaining the necessary instream flows that support a healthy fishery.

Technical considerations for Groundwater Monitoring and Modeling in the Big Sky area include:

- Number and capacity of wells
- Depth to groundwater and well water levels
- Complex geology and varied aquifer types determine water quality/quantity available to wells
- Groundwater and surface water interactions and instream flows
- Variable annual precipitation and snowpack

Maintaining the quality and quantity of the Meadow Village aquifer is a key component to the long-term sustainability of the Big Sky area’s water supply. This aquifer is relatively shallow, extending approximately 60 feet deep at its maximum depth (**Figure 2-3** in **Section 2.2**). Within the Meadow Village aquifer, groundwater is relatively close to the surface, making it vulnerable to contamination. The Meadow Village aquifer is recharged annually by winter snowpack and large rain events. Each spring, snowmelt causes a yearly pulse in groundwater, which is followed by a second pulse in groundwater elevations in the fall from a combination of precipitation and “artificial recharge” contributed from golf course irrigation. To determine the capacity of the Meadow Village aquifer, the MBMG Groundwater Investigation Program (GWIP) has been conducting a groundwater investigation over the past several years. MBMG is currently developing a groundwater model for the Meadow Village aquifer, which will allow modeling of different scenarios for groundwater withdrawal amounts, modeling impacts of changing precipitation patterns, and examining potential impacts from developing additional wells. In addition, MBMG established several new monitoring wells within the Meadow Village aquifer and BSCWSD, MBMG and GLWQD intend to continue monitoring many of these wells.

Expanding aquifer monitoring and modeling to the Lower Basin (“Canyon”) aquifer in the Gallatin Wildlife Management Area along the Gallatin River upstream of the West Fork Gallatin River confluence will provide important information regarding aquifer capacity, groundwater and surface water interactions, and potential impacts to Gallatin River streamflows. Collecting additional information on groundwater conditions in areas outside of the primary sand and gravel aquifers is also important, since natural geologic conditions in some of the sandstone and shale aquifers leads to water that is naturally high in contaminants that could negatively impact human health. A more in-depth understanding of groundwater and surface water interactions, along with the relationship between aquifer levels and instream flows, are important considerations since these interactions drive stream baseflows, instream water quality and temperatures, and directly relate to fish productivity and abundance.

Policies, Regulations and Laws relevant to Groundwater Monitoring and Modeling include Montana water law, regulations on exempt wells, stream depletion zones, controlled groundwater areas, and Source Water Protection Plans. Exempt wells are expected to be a component of Big Sky’s water supply since there is generally a lack of mitigation water available within the Big Sky area. However, changes to exempt well policies have been proposed during recent legislative sessions suggesting current policies will likely be subject to future changes. Stream depletion zones can be designated by DNRC to reduce the flow and volume allowed for exempt wells to 20 gallons per minute (gpm) and 2 acre-feet per year. The DNRC may be petitioned to establish a stream depletion zone by the BSCWSD, Gallatin County, Madison County, GCD, MCD, or GLWQD. A stream depletion zone may help minimize development’s impact on streamflows. Another potential option would be the designation of a controlled groundwater area to reduce the impact of future wells. DNRC may institute a controlled groundwater area if the petitioner shows a unique or worthy water situation and proves a water quality or quantity issue exists. Designation of a controlled groundwater area is a potential tool to manage groundwater withdrawals and would require additional data. Finally, a Source Water Protection Plan could be instituted through DEQ to safeguard Big Sky’s municipal water supply. A Source Water Protection Plan would also enable access to watershed restoration funding and grant opportunities.

Economics and Cost Considerations for Groundwater Monitoring and Modeling include the need for funding to better characterize the available groundwater resources in the Big Sky area. The MBMG GWIP is a potential source of funding for the Lower Basin (“Canyon”) aquifer study, while the MBMG also provides ongoing monitoring of established monitoring wells through the Ground Water Assessment Program (GWAP), including hourly water level data and water quality sampling every 10 years. Additional funding will be necessary to sustain ongoing water level monitoring, increase the frequency of water quality monitoring, conduct additional groundwater studies, and develop a water balance model to help manage water use and reuse. The GLWQD currently has a Groundwater Database that houses all the data collected with their district’s boundaries, along with data from domestic wells sampled through the Well Educated Program. In addition to monitoring and modeling costs, there are potential impacts to development costs if a controlled groundwater area is established since this could limit future well development. A portion of the area is already included in the Yellowstone Ground Water Control Area, which was established to protect geothermal features in Yellowstone National Park. In addition, legislative changes to the rules regarding exempt wells may impact future developments.

Community Interest and Support for Groundwater Monitoring and Modeling in the Big Sky area is strong and has included monitoring and modeling by MBMG, BSCWSD and GLWQD.

Potential Partner Organizations for Groundwater Monitoring and Modeling include MBMG, GLWQD, Task Force, BSCWSD, Big Sky Resort, Yellowstone Club, Spanish Peaks, Moonlight Basin, DEQ and DNRC.

2.2.2 Strategies for Water Conservation

The purpose of developing **Strategies for Water Conservation** is to:

- Extend existing and future water supplies by creating incentives and regulatory methods for adopting water conservation practices and programs
- Reduce the amount of wastewater generated

Strategies for Water Conservation includes activities that educate, incentivize and require water conservation so that the limited water available in the Big Sky area is used as efficiently and thoughtfully as possible.

Technical considerations for Strategies for Water Conservation include:

- Water metering, tiered pricing, and rebate programs to create incentive-based rewards program for "smart" water use
- Development of a "Trout Friendly", "Trout Certified" or "Big Sky Green Certified" certification to recognize and incentivize water users that have made specific choices that promote sustainable water use practices, which also tie into the ecological protection of our water resources
- Development of incentives and/or requirements to reduce the amount of irrigated lawns/grass/turf and convert to xeriscaping, and other low water use landscape design and irrigation systems
- Development of design requirements for landscaping and irrigation specifications, aiming to reduce summer irrigation demands
- Development of Drought Management Plans for the headwaters of the Gallatin and Madison watersheds in the Big Sky area
- Incorporate greywater systems into future commercial and residential developments
- Evaluate water lost through evapotranspiration from storage ponds and private ponds
- Decrease the use of exempt wells and individual wells, which don't require a water right, and replace with community water supplies, which do require a water right
- Educate homeowners and businesses on the ecologic and economic benefits of water efficient landscape design and irrigation systems to reduce summer irrigation demands and optimize supplies for fire control
- Educate homeowners on in-home water conservation measures and the installation of low flow appliances
- Educate community members on the realities of living in an ecologically sensitive semi-arid mountain environment situated at the headwaters of the Gallatin River and Madison River watersheds

Strategies for Water Conservation aims to inspire and/or require community members to actively engage in water conservation strategies that reduce groundwater withdrawals, maintain instream flows, and build resilience against changing climate conditions. Changing the "culture" of water use in the Big Sky area's homes and businesses to align with the realities of our semi-arid mountain climate regime, especially in outdoor water uses and landscape design, is a key component of education and outreach incentives for water conservation in the Big Sky area. Incentivizing Home Owner Associations (HOAs) and businesses to implement water conservation efforts by creating a "Trout Friendly", "Trout Certified" or "Big Sky Green Certified" certification is a near-term priority and a potential component of the Task

Forces' Big Sky Water Conservation program. Big Sky Water Conservation is a voluntary, incentive-based program seeking to inspire a water conservation ethic across the Big Sky community. Currently, this program offers rebates for residents who have made efforts to prioritize water conservation at home by installing high efficiency fixtures and appliances; indoor and outdoor rebates exist for toilets, showerheads, clothes washers, rain sensors, weather-based smart controllers, sprinkler checkups and more. This watershed stewardship plan, along with other community planning efforts, has identified interest in further expansion of this program by developing more incentive-based options for water conservation practices that are coupled with education and outreach programming. In addition to incentives for water conservation, developing regulatory requirements for water conservation that limit the extent of lawns, water features, and ponds and minimize or eliminate water usage for non-critical uses may be necessary to sustain the ecological health of the river systems. Drought planning efforts are currently underway in the Gallatin and Madison watersheds, including the development of the Upper Gallatin Drought Management Plan. Details within the drought management plans will provide guidance for the implementation of Strategies for Water Conservation. In addition, upcoming results from the MBMG GWIP Meadow Village aquifer study will be useful for evaluating groundwater management scenarios and identifying actions for maximizing the existing water supply.

Policies, Regulations and Laws relevant to Strategies for Water Conservation include water metering and tiered pricing applied by BSCWSD within their rate structure. HOAs may have requirements for landscaping and irrigation that could be revised to emphasize low water use, drought tolerant, native species planting, and xeriscaping landscape design. Expanding the Big Sky Water Conservation partnership between BSCWSD and the Task Force to create a landscape design and irrigation ordinance that outlines new water efficient specifications will be beneficial. Incentivizing new commercial and residential developments to incorporate greywater systems is another beneficial action that could be accomplished through locally adopted regulations. Petitioning the DNRC to designate a controlled groundwater area to ensure that uncontrolled well development in critical aquifers doesn't negatively impact streamflows and aquatic resources may be beneficial.

Economics and Cost Considerations for Strategies for Water Conservation include cost savings for consumers that use less water or a fee applied to high water users. A long-term funding source will be needed for rebates and to sustain conservation education programs. Adding greywater systems to new commercial and residential developments may increase construction costs, though water savings over the long-term will likely alleviate some of these costs.

Community Interest and Support for Strategies for Water Conservation is strong, and the Upper Gallatin Drought Management Plan is currently under development. As a growing resort community, there is a continual influx of new community members, many of which may be unfamiliar with the ecological limitations of living in a headwaters community in a mountain semi-arid environment. Ongoing education and outreach to HOAs, developers, real estate agents, and municipal water users will be a key component for the successful implementation of water conservation programs.

Potential Partner Organizations to implement Strategies for Water Conservation include local non-profit organizations, including the Task Force, BSCO, and TU, along with BSCWSD, Yellowstone Club, Spanish Peaks, Moonlight Basin, Big Sky Resort, local realtors and HOAs in the Big Sky area, many of which are under the umbrella of the BSOA. In addition, county governments and planning departments can play a role in incentivizing and regulating water conservation.

2.2.3 Stormwater Management

The purpose of **Stormwater Management** is to:

- Minimize environmental impacts from existing and anticipated increased stormwater runoff by identifying opportunities for stormwater beneficial reuse

Technical considerations for Stormwater Management include actions to enforce existing stormwater regulations, improve current and future stormwater management, follow Best Management Practice (BMPs), and encourage low impact development and the creation of “green” infrastructure. Activities to capture and reuse stormwater include:

- Strengthen stormwater requirements for future developments
- Implement "Slow the Flow" stormwater management to collect rain water and snowmelt, clean it, and discharge it to groundwater
- Install bioswales, engineered wetlands, rain gardens, and permeable pavement
- Utilize rainwater cisterns to capture rain water for irrigation use
- Prevent the runoff of winter traction sand from road and parking lot surfaces
- Explore Municipal Separate Storm Sewer System (MS4) designation

As more of the Gallatin River and Madison River watersheds are converted from native vegetation cover to pavement and rooftops, slowing the flow of water through the system by improving stormwater management will provide for aquifer recharge and increased late-season streamflows, while also providing resiliency for changing climate conditions. In addition, improved stormwater management will reduce inputs of sediment, nutrients and pathogens to streams, which will improve water quality and address stormwater contributions to streams identified as impaired by DEQ. To improve stormwater management, a holistic approach will be required and the creation of MS4 "style" regulation for the Big Sky area is one option. Additional data collection, modeling and analysis will be required to submit a MS4 petition. Mapping existing stormwater outfall locations, modeling stormwater flow, and identifying areas where stormwater treatment could be implemented are necessary first steps in the development of a holistic stormwater management plan for the Big Sky area. Addressing both the construction phase of a home and the residential phase are also important considerations for long-term management of stormwater infrastructure.

As the Big Sky area is developed, the area covered by impervious surfaces will increase. Evapotranspiration and infiltration decrease while direct runoff increases with increased impervious surfaces (Arnold and Gibbons 1996). A model was developed to assess the effect of increasing impervious area on annual water yield in the West Fork Gallatin River watershed and the results are presented in **Appendix H**. Model results indicate that increasing impervious surfaces in the Big Sky area will result in streamflow spikes during precipitation events in late-summer and fall. This is due to more precipitation running directly into the stream channel rather than being taken up by vegetation or absorbed into the groundwater system. The model also indicates late-fall and winter streamflows are diminished, likely due to reductions in groundwater volume which is the source of baseflows throughout the winter. A more robust assessment of annual water yield for the West Fork Gallatin River watershed could be achieved. Additional streamflow and precipitation measurements, accompanied by a more detailed analysis of the conversion of vegetative cover to impervious surfaces, will provide a more

thorough understanding of development's effect on annual water yield, timing of runoff, and the available water supply.

Policies, Regulations and Laws relevant to Stormwater Management include DEQs regulations on stormwater discharges associated with construction activities with greater than 1 acre of disturbance, which are authorized under the Montana Pollutant Discharge Elimination System (MPDES). Greater enforcement capacity is likely needed for this program to truly be effective in the Big Sky area. For cities with greater than 10,000 people, MS4 regulations apply to stormwater discharges. While the Big Sky area does not currently meet the requirements of the MS4 regulations, this program could be implemented through community petition. This has not previously been done in Montana and being geographically located in two counties may make the process more complex. Relative to water quality, TMDLs for sediment contributions from stormwater inputs have been developed for the Middle Fork West Fork Gallatin River, South Fork West Fork Gallatin River, and West Fork Gallatin River. Relative to water rights, the DNRC allows maximum storage of 0.1-acre feet of water without a water right. Addressing HOA rules and providing for a comprehensive program to maintain stormwater features are also components of improved stormwater management in the Big Sky area.

Economics and Cost Considerations for Stormwater Management include the potential for increased fees since MS4 areas can assess impact fees and set controls. In addition, expanding Stormwater Pollution Prevention Plan (SWPPP) requirements during construction could add to housing costs, which are already high within this resort community. There may also be reductions to individual water use costs that are realized by slowing and reusing water on site.

Community Interest and Support in Stormwater Management is unknown, but there is a general lack of knowledge on stormwater infrastructure and capture and reuse techniques within the Big Sky area. Education and outreach to both developers and HOAs will be a key component to implementing a successful stormwater management program in the Big Sky area.

Potential Partner Organizations to implement Stormwater Management include the Task Force, DEQ, BSCWSD, Yellowstone Club, Spanish Peaks, Moonlight Basin, Big Sky Resort, and Town Center, along with other developers and construction contractors operating in the Big Sky area. In addition, HOAs and BSOA will be primary partners in the long-term operation and maintenance of stormwater retention facilities.

2.2.4 Mitigation of Water Rights

The purpose of **Mitigation of Water Rights** is to:

- Allow changes to existing water rights, and improve streamflows to meet FWP instream flow reservations

Montana is a Western Doctrine state, so water use is “first in time, first in right”. The Upper Missouri River basin and Jefferson and Madison basin are closed to new appropriations of water and the Gallatin River and Madison River are over-appropriated for irrigation and instream fishery purposes. Changes to water rights must provide mitigation for adverse effects caused to other existing water rights, including downstream senior water rights for agriculture and hydropower. Because the Big Sky area is in a closed basin, mitigation will have to come from historical rights, with irrigation water rights typically providing the most water for mitigation.

Technical considerations for Mitigation of Water Rights include the challenge of converting a seasonal irrigation water right located in the valley areas of the watershed into mitigation for year-round water use further upstream in the mountainous areas of the watershed. Mitigation could potentially provide for aquifer recharge, increased streamflows, decreased stream temperatures, and enhanced wetland and riparian habitat, but mitigation must be executed thoughtfully to prevent negative impacts to water rights holders, particularly agricultural producers and fisheries. As existing water uses, such as irrigation and snowmaking that draw on existing groundwater and surface water rights, are converted to reused water, opportunities will arise to lease or convert the existing water rights into instream flows rights, which would benefit the ecological health of the river systems. Some avenues for further investigation regarding mitigation of water rights include:

- Complete the second decree stage of adjudication for the Gallatin River basin (anticipated in 2018)
- Complete the second decree stage of adjudication for the Madison River basin (anticipated in 2020)
- Convert 100% consumptive (“fully consumed”) water rights (i.e. land application) to less consumptive (i.e. snowmaking)
- Use non-perfected water rights as mitigation for future water rights
- Support Montana Aquatic Resource Services (MARS) in establishing a mitigation bank to provide a predictable, market-stable mechanism for changing water rights

Policies, Regulations and Laws relevant to Mitigation of Water Rights include Montana Water Law and the Montana DNRC water rights rules for new appropriations and change applications. The Montana Water Court will be adjudicating the Gallatin River basin in the near future. With a water right, a certain amount is applied to a specific acreage. Currently, the change process involves an evaluation of the consumptive portion of the water right (the portion taken up by the plants), which is the portion of the water right available for sale. Legislative law changes may be needed to expand the legal breadth of what might constitute suitable mitigation. Through these actions, water policy could be created that allows excess water to be routed into wetlands in a way that recharges groundwater, filters out contaminants, and adds mitigation value to the discharger. In addition, FWP holds instream flow reservations which are not always met.

Economics and Cost Considerations for Mitigation of Water Rights include the costs for setting up and maintaining a mitigation bank, for which the Gallatin mitigation exchange is currently being formed by MARS to facilitate water rights transactions with a value based on market forces. This is currently a nascent market, with few clear buyers and sellers.

Community Interest and Support for Mitigation of Water Rights within the Big Sky area is unknown. The vast majority of water rights holders reside downstream of the Big Sky area in the agricultural producing areas of the Gallatin and Madison valleys, and engagement with the agricultural community will be a key component for successful mitigation projects. The agricultural community is concerned about uncertainties in the amount of water a right actually contains since this is re-evaluated during the change process. This uncertainty impairs transactions between sellers and buyers because the actual value of the water right is unknown. In addition, the agricultural community is also concerned that a transfer of water rights from irrigation in the valleys to development in the Big Sky area would lead to reduced streamflows in the Gallatin and Madison rivers.

Potential Partner Organizations to implement Mitigation of Water Rights include large scale developers and water users, such as BSCWSD, Yellowstone Club, Spanish Peaks, Moonlight Basin, Big Sky Resort, and Town Center, along with agricultural producers in the Gallatin and Madison valleys, including the Association of Gallatin Agricultural Irrigators (AGAI), DNRC, which administers water rights, FWP, which holds instream flow reservations, and TU. In addition, MARS is setting up a mitigation exchange that will provide a source of mitigation credits and an avenue for executing water rights transactions.

2.3 WASTEWATER TREATMENT AND REUSE

For **Wastewater Treatment and Reuse**, the Water Forum stakeholders reached consensus in five areas:

- 1) Treat Wastewater to the Limits of Technology
- 2) Address Septic Systems and Small Community Systems
- 3) Expand Water Reuse for Irrigation
- 4) Develop Water Reuse for Snowmaking
- 5) Investigate Shallow Groundwater Recharge

Within the West Fork Gallatin River watershed, BSCWSD is currently the largest provider of wastewater treatment. The BSCWSD service area includes Big Sky Resort, Spanish Peaks and Town Center, along with businesses and private residences (**Figure 1-5** in **Section 1.5.2**). Outside of the BSCWSD boundary, wastewater is treated by individual septic systems and small community systems. The Yellowstone Club has recently upgraded their wastewater treatment plant to accommodate future growth. Within the Jack Creek watershed (tributary to the Madison River), Moonlight Basin provides wastewater treatment to most of the development, though some residences have septic systems. The recently completed *Resort Area Wastewater Analysis, Big Sky, MT* (WGM 2015) provides an estimate of 450.6 Million Gallons per Year (MGY) of wastewater generated from BSCWSD, Yellowstone Club, Spanish Peaks and Moonlight Basin at full build-out, which is anticipated to occur by 2035, compared to existing wastewater generation of 155.6 MGY and an existing treatment capacity of 273.8 MGY (**Table 2-6**). Thus, expanded wastewater treatment will be required to meet the needs of future development and growth in the Big Sky area. Within the Gallatin Canyon, there are several small community systems, including treatment systems at Ophir School, Ramshorn subdivision, and Buck's T4, along with numerous individual septic systems. Within Gallatin County, a total of 963 septic permits have been approved in the Big Sky area between 1966 and 2016. The Gallatin City-County Health department developed a preliminary calculation based on current septic permits and estimated that at least 123.7 (MGY) is generated and treated through septic systems in the area from Cinnamon Lodge to Karst (Highway 191 Mile Markers 37 through 55) (Moore 2017). Wastewater generation projections in the *Preliminary Engineering Report Canyon Area Wastewater Treatment and Disposal* study (DOWL HKM 2008) estimated that growth over 20 years (2010-2030) at 5.6% would result in 283,000 gallons per day of wastewater generated from the "lower canyon area", which equates to 103.3 MGY.

Table 2-6. Wastewater Generation and Treatment Capacity

Entity	Watershed	Existing (MGY)	Capacity (MGY)	Predicted - 2035 (MGY)
BSCWSD	West Fork Gallatin River	139.1	219.0	313.8
Yellowstone Club	West Fork Gallatin River	7.3	18.3	23.4
BSCWSD and YC Total	West Fork Gallatin River	146.4	237.3	337.2
Moonlight Basin	Jack Creek	9.2	36.5	113.4
Grand Total		155.6	273.8	450.6

Wastewater generated in the West Fork Gallatin River watershed is held in a series of wastewater storage ponds over the winter and land applied to area golf courses during the summer irrigation season (May-October). Storage is provided by three ponds at the BSCWSD wastewater treatment plant, along with a pond at the Yellowstone Club and a recently constructed pond at Spanish Peaks (**Table 2-7**). Within the West Fork Gallatin River watershed, 146 MGY of wastewater is currently generated and there

is 195 MG of existing storage capacity (**Tables 2-6 and 2-7**). Thus, there is currently sufficient storage to manage wastewater on an annual basis. However, as wastewater generation increases, storage requirements will exceed the existing capacity and alternatives will need to be developed, including expanding storage and altering the type and timing of wastewater reuse. Outside of the West Fork Gallatin River watershed, wastewater is stored in two ponds maintained by Moonlight Basin, while Buck's T4 in the Gallatin Canyon provides storage for wastewater generated from their public water system.

Table 2-7. Treated Wastewater Storage Capacity

Entity	Watershed	Storage Capacity (MG)
BSCWSD - Pond 1 (SBR Effluent)	West Fork Gallatin River	8.2
BSCWSD - Pond 2 (Large)	West Fork Gallatin River	60.1
BSCWSD - Pond 3 (Small)	West Fork Gallatin River	19.6
BSCWSD - Pond Total	West Fork Gallatin River	87.9
BSCWSD & Yellowstone Club	West Fork Gallatin River	80.0
BSCWSD & Spanish Peaks	West Fork Gallatin River	27.0
BSCWSD - Grand Total	West Fork Gallatin River	194.9
Moonlight Basin - Primary Pond	Jack Creek	11.5
Moonlight Basin - Backup Pond	Jack Creek	2.5
Grand Total		208.9

Within the West Fork Gallatin River watershed, treated wastewater is currently land applied to the Big Sky Golf Course, Big Sky Community Park and the Yellowstone Club Golf Course and will be land applied to the Spanish Peaks Golf Course in the future. Within the Jack Creek watershed, wastewater is currently land applied to forested areas, with future plans to apply wastewater to the Moonlight Basin Golf Course. Golf course irrigation capacities are estimated in the recently completed *Wastewater System Master Plan Update for Big Sky County Water and Sewer District 363* (DOWL 2015) (**Table 2-8**). Big Sky area golf courses and the community park currently support an estimated 202 MGY of irrigation in a wet year and an estimated 270 MGY of irrigation during a dry year. As wastewater effluent generation in the Big Sky area exceeds 202 MGY, alternatives to golf course irrigation will need to be developed to effectively reuse an estimated additional 180 MGY (dry year) to 248 MGY (wet year) of wastewater effluent to achieve 450 MGY of total reuse capacity.

Table 2-8. Wastewater Reuse Capacity using Land Application

Entity	Watershed	Wet Year (MG)	Dry Year (MG)
BSCWSD - Big Sky Golf Course	West Fork Gallatin River	140	160
BSCWSD - Yellowstone Club Golf Course	West Fork Gallatin River	22	28
BSCWSD - Spanish Peaks Golf Course	West Fork Gallatin River	20	30
BSCWSD - Total	West Fork Gallatin River	182	218
Moonlight Basin Golf Course*	Jack Creek	20	52
Grand Total		202	270

* Moonlight Basin currently irrigating 17 acres of forest

Additional background information on Wastewater Treatment and Reuse in the Big Sky area can be found in **Appendix D**, which provides a summary of stakeholder presentations at the November 3, 2016 Water Forum stakeholder meeting, including presentations from BSCWSD, Yellowstone Club, Lone Mountain Land Company, Buck's T-4, Gallatin City-County Health Department, DEQ and RESPEC.

2.3.1 Treat Wastewater to the Limits of Technology

The purpose of **Treating Wastewater to the Limits of Technology** is to:

- Ensure there are no negative impacts to the ecological health of the river systems and provide high quality reclaimed water to maximize reuse options

To ensure that wastewater generated in the Big Sky area doesn't negatively impact the ecological health of the river systems, it will need to be treated to a high level and wastewater reuse will need to be carefully managed and monitored. The current limits of technology can achieve a Total Nitrogen concentration of 2 mg/L and a Total Phosphorus concentration of 0.5 mg/L. The premise behind treating wastewater to the maximum extent possible is that the higher the level of treatment, the more treated wastewater can be used in a way that meets community needs and provides ecological benefits. In addition, it is the expressed intent of the Water Forum's stakeholders that the Big Sky community exceeds Montana's water quality standards and be a model for other communities to sustainably develop in an ecologically sensitive area while maintaining the ecological health of the river systems.

Technical considerations for Treating Wastewater to the Limits of Technology include:

- Determine the required treatment levels and the necessary infrastructure improvements for various reuse alternatives, including irrigation, snowmaking and shallow groundwater recharge
- Identify effective technologies to remove personal care products (PCPs), pharmaceuticals, endocrine disrupters, micro-plastics, and pollutants of emerging concern (PECs)
- Examine additional treatment opportunities such as "floating islands" in storage ponds and constructed treatment wetlands
- Actively monitor water quality in treated effluent and affected surface waters, including:
 - Total Nitrogen
 - Ammonia
 - Total Phosphorus
 - Biological Oxygen Demand
 - *E. coli / coliform*
 - Chloride
 - Priority Pollutants
 - Pharmaceuticals
 - Whole Effluent Toxicity
- Perform assessments to differentiate various contributions of non-point source nutrient inputs into the river system and adequately quantify wastewater nutrient inputs due to irrigation, snowmaking, and shallow groundwater recharge
- Include aquifer recharge, streamflow and stream temperature considerations when examining the desired level of treatment, along with the type and timing of wastewater reuse

Water is a limited resource in the Big Sky area and beneficially reusing treated wastewater to augment water supply needs for irrigation, snowmaking and shallow groundwater recharge can provide ecological benefits, including aquifer recharge and improved streamflows. Nutrients in wastewater are also a valuable resource when managed in ways that do not negatively impact the ecological health of the river systems. Wastewater reuse for irrigation is required to be fully consumptive and represents a net loss of water from the system. While irrigation reuse does not require a discharge permit from DEQ if it

is fully consumptive, both snowmaking and shallow groundwater recharge reuse alternatives do require a discharge permit. Determining the appropriate treatment level to meet permitting requirements for snowmaking and shallow groundwater recharge with reclaimed water will be necessary, along with an evaluation of the potential impacts to water quality and streamflows to ensure that the ecological health of the river systems is maintained. Snowmaking and shallow groundwater recharge reuse alternatives are likely to be instituted within the West Fork Gallatin River watershed, in which the Middle Fork West Fork Gallatin River, South Fork West Fork Gallatin River and West Fork Gallatin River are already considered impaired by DEQ for nitrogen-related nutrient inputs. Thus, water quality improvements will need to be realized in these waterbodies to ensure that nutrients do not lead to excess algal growth. Sustaining and enhancing streamflows, particularly during the hottest part of the summer is also a consideration for all reuse alternatives, since this directly benefits the fisheries resource.

Given the predicted level of growth in the Big Sky area and accompanying challenges for wastewater treatment, storage, and reuse capacities, treating wastewater to the limits of technology will create more options for beneficial reuse. Assuming an existing land application capacity during a wet year of 202 MGY, along with an estimated 120 MGY of treatment using septic systems in the Canyon area, results in a total reuse capacity of 322 MGY in the Big Sky area in 2017 (**Figure 2-4**). A predicted effluent generation of 450 MGY in Big Sky area by 2035, combined with an assumption that septic systems in the Canyon will continue to generate approximately 120 MGY, results in 570 MGY of wastewater generated in the Big Sky area by 2035. Thus, suitable reuse alternatives need to be identified for at least 248 MGY by 2035 and expanding water reuse through irrigation and snowmaking could address much of this need. Increased generation of wastewater in the Canyon area would result in a higher amount of wastewater to treat and reuse, while reducing overall wastewater generation by 10% through conservation efforts would alleviate some of the need for expanded wastewater treatment and reuse.

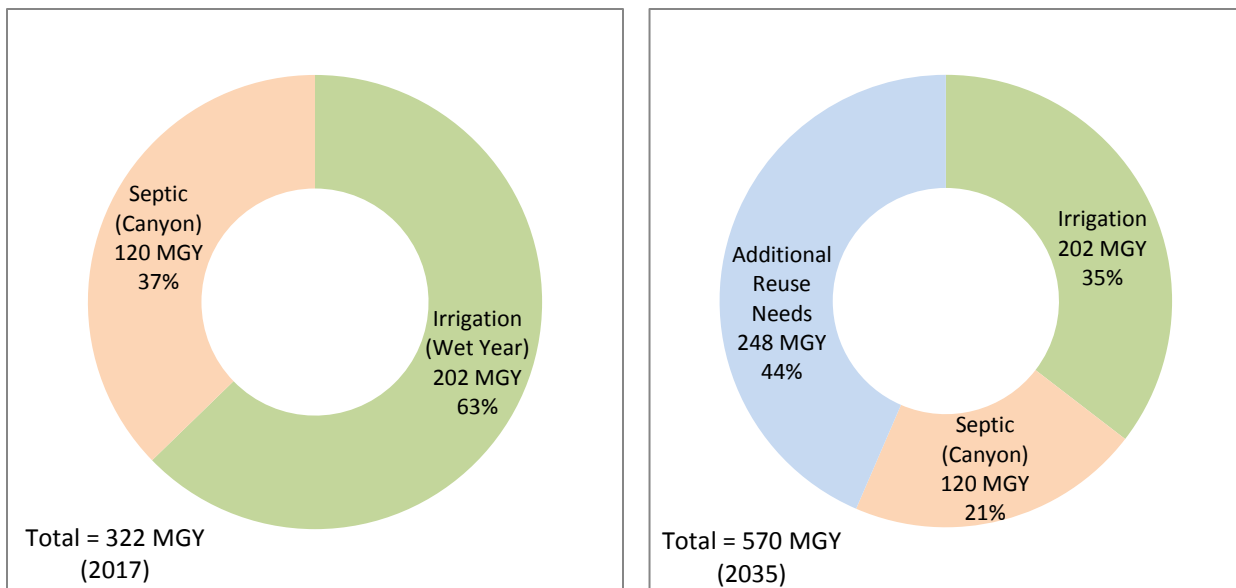


Figure 2-4. Wastewater Reuse Capacity in 2017 and Capacity that Needs to be Achieved by 2035

Policies, Regulations and Laws relevant to Treating Wastewater to the Limits of Technology and ensuring it meets the required treatment limits depend on the type of reuse alternative. Land application of treated wastewater effluent through irrigation, snowmaking and shallow groundwater

recharge are subject to the requirements in DEQ Circular-2 Appendix B. Since snowmaking with treated wastewater effluent has not previously been permitted in Montana, working with the DEQ to develop rules and regulations will be necessary. A pilot project conducted by Yellowstone Club in partnership with BSCSWD and DEQ provides a foundation for developing the regulatory framework for this reuse alternative. In addition, ski areas in other states are using treated wastewater effluent for snowmaking, which could provide a template for the development of this program in Montana. Shallow groundwater recharge may result in interconnection with adjacent surface water, resulting in a need to secure a surface water discharge permit that may also contain groundwater provisions.

Relative to surface water quality, DEQ Circular-12A specifies a Total Nitrogen concentration of 0.3 mg/L (300 µg/L) and a Total Phosphorus concentration of 0.03 mg/L (30 µg/L) for the July 1 to September 30 timeframe for streams in the Middle Rockies Ecoregion in which the Big Sky area is located. Outside of the July 1-September 30 timeframe, the DEQ has not established numeric nutrient criteria. In addition, there are nutrient TMDLs for the Middle Fork West Fork Gallatin River, South Fork West Fork Gallatin River, and West Fork Gallatin River, so wastewater effluent will need to be treated to a high level so that nutrient concentrations do not exceed Montana's water quality standards. Nutrient targets in the West Fork Gallatin River Watershed TMDL document include direct measures of nutrient concentrations in surface waters, along with measures of benthic algae chlorophyll *a* concentrations, which are directly related to beneficial use impairment, including (DEQ 2010):

- Nitrate+nitrite (NO_3+NO_2) \leq 0.10 mg/L
- Total Nitrogen (TN) \leq 0.32 mg/L (superseded by a requirement of TN \leq 0.30 mg/L in DEQ-12A)
- Total Phosphorus (TP) \leq 0.03 mg/L
- Chlorophyll *a* \leq 129 mg/m²

Economics and Cost Considerations for Treating Wastewater to the Limits of Technology include increased infrastructure costs, along with ongoing operations and maintenance costs that increase as the level of treatment increases. While State funding may cover a portion of the costs through grants and loans, bonding will be required for wastewater treatment plant improvements. A primary decision point for the BSCWSD is to determine if all water should be treated to the highest level possible, or if only certain reuse alternatives, such as snowmaking, need to be treated to the highest level possible, while other alternatives, such as golf course irrigation, could potentially be treated to a level that aligns with plant nutrient uptake requirements. Thus, there is a potential for a "split stream" of wastewater treatment with treatment levels varying based on the reuse destination for reclaimed water.

Community Interest and Support for Treating Wastewater to the Limits of Technology is very high and there is strong support for wastewater reuse alternatives that don't involve directly discharging wastewater effluent into the Gallatin River. Wastewater treatment and disposal concerns expressed by the community are generally focused on the potential for negative impacts to the Gallatin River, including degradation of water quality, aesthetics, fisheries and the recreational experience, along with a negative economic impact that may result.

Potential Partner Organizations for Treating Wastewater to the Limits of Technology include BSCWSD, Yellowstone Club, and Moonlight Basin, which are the primary operators of public wastewater treatment systems in the Big Sky area. In addition, future development of new centralized treatment for areas now served by septic systems will require additional partners.

2.3.2 Address Septic Systems and Small Community Systems

The purpose of Addressing Septic Systems and Small Community Systems is to:

- Ensure existing and future individual septic systems and small community systems are being installed and maintained to provide optimal wastewater treatment

Septic systems and small community systems contribute significantly higher nutrient loads than advanced centralized treatment systems, but are often the best suited and most feasible wastewater treatment system for low-density development. Septic systems include individual onsite wastewater treatment systems, which can be either Level 1 primary septic systems or Level 2 advanced wastewater treatment systems. Small community wastewater treatment systems are installed by developers during construction of a subdivision and treatment levels vary depending on the design. In general, treatment levels are 40-60 mg/L Total Nitrogen for Level 1 systems and 20-30 mg/L Total Nitrogen for Level 2 systems.

Technical considerations for Addressing Septic Systems and Small Community Systems to minimize nutrient loading to groundwater and surface water include:

- Number of septic systems
- Condition of septic systems
- Proximity of septic systems to surface water in streams and rivers
- Groundwater nitrate concentrations
- Expansion of BSCWSD boundaries or establishment of a new district
- Identification of areas where centralization of wastewater treatment is feasible compared to areas where individual septic systems are best suited
- Additional treatment through centralization will require additional options for the reuse of treated wastewater

Septic systems are a long-established practice that can be implemented by individual landowners. However, regular maintenance of septic systems is required to maintain performance. In addition, the cumulative environmental impact of multiple individual systems is difficult to monitor since they are dispersed across the landscape. While the BSCWSD is currently equipped to handle septage pumped from local septic systems, there are concerns regarding the source of the septage and what might be included, especially grease, which can foul the BSCWSD treatment equipment. Thus, septage is typically transported to Gallatin Valley locations, though it is reportedly getting more difficult to find sites in the valley for septage due to increased development in areas historically used for agriculture. Hauling septage down the Gallatin Canyon also poses hazards for an accidental spill into the Gallatin River. Over the long-term, transitioning from septic systems and small community systems to centralized wastewater treatment is considered beneficial for water quality and a strategy for centralizing wastewater treatment should be developed. Decreasing the number of septic systems and replacing them with the higher treatment levels provided by centralized treatment would benefit water quality by reducing groundwater nitrogen and phosphorus inputs, while also converting an unquantifiable non-point source of nutrients into a known and quantifiable point source.

Policies, Regulations and Laws relevant to Addressing Septic Systems and Small Community Systems include DEQ and county health regulations, which are applied at the time of initial construction and dictate a required distance between the septic system and the well site. Current regulations include groundwater and surface water analysis, but are limited in their ability to evaluate cumulative impacts since sites are reviewed on an individual permit basis. Currently, septic permitting can only be halted if degradation limits in groundwater or surface are detected. Existing laws allow for the establishment of a septic maintenance district, which may be beneficial. Developing disclosure requirements when property is transferred and establishing a septic education program during the permitting process may also be beneficial. In addition, voter approval will be required to expand BSCWSD or to establish a new district if centralization is pursued.

Economics and Cost Considerations for Addressing Septic Systems and Small Community Systems include the expense to the individual landowner (onsite septic system) or developer (small community system) for the initial installation of the system, along with long-term maintenance costs. In addition, it is more expensive to install higher level treatment systems, which provide for improved water quality, but also need to be maintained properly to be effective and require operation and maintenance agreements with the proprietary installer. Coordinating a strategy for centralizing a portion of the septic systems in Gallatin Canyon with Gallatin County will help prioritize septic system upgrades in areas that are unlikely to be incorporated into a centralized system. Centralization of wastewater treatment will also require the expansion of the existing BSCWSD or establishment of a second district, which will require a substantial financial investment. State funding may cover a portion of the costs, though bonding will also be required. Over the long-term, there are potential cost-savings for customers on centralized wastewater treatment systems.

Community Interest and Support for Addressing Septic Systems and Small Community Systems has an unknown level of acceptance and ongoing education and outreach is necessary to ensure that new landowners understand how to properly maintain their septic systems. Among property owners currently operating septic systems and small community systems, the level of support for expansion of the existing BSCWSD boundary or establishment of a second district is unknown, though there may be resistance from landowners that have invested in upgrades to individual septic systems and small community systems. If centralized treatment through BSCWSD is a desired priority, then the likely approach for the district would be to have “Phase 1” address existing commitments within the current district boundaries followed by a “Phase 2” to address extensions into the Gallatin Canyon and into areas within the West Fork Gallatin River watershed that are not currently within the district. In addition, existing zoning in Gallatin Canyon allows for high density development, which may only be possible if the area is placed on a centralized sewer system. Thus, potential changes to zoning requirements should be considered by the community.

Potential Partner Organizations for Addressing Septic Systems and Small Community Systems include DEQ, HOAs, Gallatin City-County Health Department, GLWQD, HOAs, developers, Gallatin and Madison counties, Task Force, BSCWSD, and individual septic and small community system owners and operators.

2.3.3 Expand Water Reuse for Irrigation

The purpose of **Expanding Water Reuse for Irrigation** is to:

- Extend water supplies by maintaining existing golf course and community park irrigation with treated wastewater effluent and identifying additional irrigation opportunities in open spaces and residential areas

Wastewater reuse currently occurs in the form of irrigation on Big Sky area golf courses, Big Sky Community Park, and forested areas. Expanding wastewater reuse to new areas and increasing the number of times wastewater is reused will help stretch the existing water supply within the Big Sky area, while reducing the need to use groundwater and surface water for irrigation.

Technical considerations for Expanding Water Reuse for Irrigation include:

- Maintain golf course irrigation with reclaimed water on the Big Sky Resort Golf Course, Big Sky Community Park and Yellowstone Club Golf Course in a way that doesn't negatively impact the ecological health of the river systems
- Expand golf course irrigation with reclaimed water to the Spanish Peaks Golf Course and Moonlight Basin Golf Course
- Expand irrigation with reclaimed water to residential areas, business complexes and open spaces by expanding the purple pipe network
- Improve effluent water quality to ensure there are no negative impacts to the river systems
- Ensure land application rates are fully consumptive so that water doesn't percolate into the shallow groundwater system or enter surface waters
- Track land application nutrient loads with a nutrient loading database and develop a plan for coordination between BSCWSD and irrigating entities
- Expand reservoir storage capacity and develop a strategy for irrigation timing considerations
- Install latest technology irrigation control systems that account for precipitation

There is existing infrastructure for the land application of treated wastewater effluent using sprinkler irrigation at the Big Sky and Yellowstone Club golf courses and the Big Sky Community Park. The BSCWSD has extensive experience with this reuse method, typically land applying approximately 120-140 Million Gallons per Year (MGY) of treated wastewater at the Big Sky Golf Course and 20-25 MGY at the Yellowstone Club Golf Course. Expanding irrigation with reclaimed water on the Spanish Peaks Golf Course (approximately 20-30 MGY coming online), along with irrigating the Moonlight Basin Golf Course in the future, will further expand water reuse capabilities. This system of reuse relies on a series of storage ponds that store treated wastewater effluent starting in November and extending through the winter until land application begins in May. In addition to expanding irrigation, modernizing greenspace management in currently irrigated areas by upgrading irrigation control systems would benefit management of the Big Sky Golf Course. Tracking land application nutrient loads with a nutrient loading database would provide additional insight that could be used to manage the purchase and application of fertilizers. Beyond golf course irrigation, development of a purple pipe network could expand the amount of irrigable area to include open spaces in the Town Center and residential areas adjacent to the Big Sky Golf Course in the Meadow Village area.

Challenges facing Expanding Water Reuse for Irrigation in the Big Sky area include:

- Fragmented management between entities
- Reclaimed water volume is projected to exceed storage capacity and irrigable area in the near-term
- Requires storage in ponds over winter with a short timeframe for discharge (May-October)
- Storage ponds require periodic maintenance and can be subject to failures
- Purple pipe installation can be expensive in areas already developed
- Irrigation water applied in excess may degrade shallow groundwater and surface water quality
- Old drain tiles underlying the Big Sky Golf Course potentially drain to the West Fork Gallatin River
- Potential for "drift" of irrigation water into adjacent streams when running sprinklers in windy conditions
- Sprinkler irrigation cannot be conducted in areas that are mapped landslides or have slopes greater than 20-30%
- Land application of reclaimed water via sprinkler irrigation of forests is available in some areas, but is not considered a particularly beneficial reuse

The *Big Sky, Montana Meadow Village Golf Course Nutrient Management Plan* (DOWL HKM 2012) indicates the golf course is approved to apply 150 pounds Total Nitrogen per acre per year (pounds/acre/year) to 185 acres and adjacent roughs with a 50-foot setback from existing streams. It is estimated that 36 pounds/acre/year of nitrogen is supplied through grass clippings and 5.5 pounds/acre/year is provided through fertilizer, leaving 108 pounds/acre/year that can be applied with reclaimed wastewater (DOWL HKM 2012). The *Wastewater System Master Plan Update* (DOWL 2015) indicates that current treatment from the BSCWSD's two basin Sequencing Batch Reactor is designed to reduce Total Nitrogen to 10mg/L, which meets the 15 mg/L Total Nitrogen approved for land applied water on the Big Sky Golf Course. Re-evaluating the capacity for irrigation water quantities and required nutrient concentrations on the Big Sky Golf Course to assess hydrologic connections with shallow groundwater and surface water in the West Fork Gallatin River will inform future management decisions. Currently, the *Long-term Compliance Work Plan for Wastewater Treatment and Disposal* (HKM 1998) specifies an irrigation requirement for the Big Sky Golf Course of 53.3MG in the wettest year in 10, with irrigation applications in excess of 53.3 MG percolating past the root zone into the underlying gravels, which were calculated to have the capacity to drain approximately 90.0MGs, for a total irrigation capacity of 143.4 MG over the 137-day irrigation season (May-October). The upcoming results of the MBMG GWIP Meadow Village aquifer study will provide insights into groundwater and surface water interactions through this reach of the West Fork Gallatin River and will be a useful tool for evaluating various groundwater withdrawal and recharge scenarios. The results of this assessment will be used for the adaptive management of irrigation with treated wastewater effluent on the Big Sky Golf Course.

Policies, Regulations and Laws relevant to Expanding Water Reuse for Irrigation include regulations outlined in DEQ Circular-2, which require treated wastewater be land applied at rates that are 100% consumptive in order to be in compliance with the design criteria. If this is the case, then land application provides for disposal without a MPDES discharge permit based on the premise that it is applied at agronomic uptake rates. In addition, the West Fork Gallatin River Watershed TMDL document (DEQ 2010) identifies land applied wastewater as a nutrient source leading to water quality impairments in the West Fork Gallatin River, so reclaimed water used for irrigation will need to be treated to an

appropriate level and applied in such a way that nutrient concentrations do not increase in local streams. For residential reuse of treated wastewater to irrigate lawns, incentive based strategies are a potential for HOAs, while locally established requirements are a potential for new commercial developments. In addition, the BSCWSD, Yellowstone Club, Spanish Peaks and Big Sky Resort coordinate wastewater treatment, storage and reuse in the West Fork Gallatin River watershed through a series of contractual agreements and there is an ongoing need for coordination among these entities to ensure existing commitments are being met.

Economics and Cost Considerations for Expanding Water Reuse for Irrigation include the costs for maintaining the existing irrigation network and storage ponds, along with potential costs for expanding the irrigation network and constructing additional storage ponds. Adding a purple pipe system to provide for irrigation within existing developments is costlier than adding purple pipes to new developments. Another cost consideration is the required land base for storage pond construction, including the cost of the land and identification of suitable sites. The availability of irrigable land is also a consideration, along with land ownership, which often requires third party agreements and coordination for operation, such as in the case with the BSCWSD land applying treated wastewater effluent to property owned by Big Sky Resort and the Yellowstone Club.

Community Interest and Support is strong for Expanding Water Reuse for Irrigation. Within the Big Sky area, treated wastewater effluent is used for irrigation on the golf courses, including the entire Big Sky Resort Golf Course and the fairways and rough of the Yellowstone Club Golf Course, along with the baseball fields at the Big Sky Community Park. There is a general sentiment that irrigating forests, as is currently occurring at Moonlight Basin, is not the best use of reclaimed water.

Potential Partner Organizations for Expanding Water Reuse for Irrigation include BSCWSD, Yellowstone Club, Spanish Peaks, Moonlight Basin, Big Sky Resort, Town Center, HOAs, and other developments in the Big Sky area, along with the Task Force, MCD, MBMG, GLWQD, TU and DEQ.

2.3.4 Develop Water Reuse for Snowmaking

The purpose of **Developing Water Reuse for Snowmaking** is to:

- Expand beneficial reuse of treated municipal wastewater by utilizing seasonal snowmaking
- Create ecological benefits associated with a “snow bank” that recycles water higher in the watershed and allows it to flow through the groundwater and surface water system more slowly, potentially enhancing late-season flows

Technical considerations for Developing Water Reuse for Snowmaking include:

- Determining the required wastewater treatment levels and necessary infrastructure improvements to implement this program by the 2020 ski season
- Reconciling storage with capacity and commitments between BSCWSD, Yellowstone Club, Spanish Peaks and Big Sky Resort
- Develop coordinating mechanism between BSCWSD and ski resorts
- Determine potential for snowmaking at Lone Mountain Ranch
- Develop streamflow and water quality monitoring network to track affected surface waters
- Perform assessments to differentiate the various contributions of non-point source nutrient inputs into the river systems and adequately quantify changing nutrient inputs due to snowmaking

Snowmaking with treated wastewater effluent provides for water storage and runoff patterns in sync with the natural hydrologic cycle, with water stored during the winter in the upper watershed that is released during spring runoff. This supports high streamflows during spring runoff necessary for maintaining dynamic instream habitat and provides for aquifer recharge that supports late-season streamflows. Preliminary estimates by area ski resorts indicate Yellowstone Club could potentially utilize 30-40 Million Gallons (MG) of treated wastewater effluent per season for snowmaking on expanded ski terrain on Eglise Ridge. Big Sky Resort currently utilizes approximately 100 MG of fresh water per season for snowmaking from existing surface water rights and estimates that as much as 300 MG of treated wastewater effluent could be utilized for snowmaking at Big Sky Resort. Utilizing treated effluent would replace the use of existing surface water from the Middle Fork West Fork Gallatin River in Lake Levinsky and expand the amount of terrain where snowmaking occurs. The existing storage pond at the Yellowstone Club, which receives water from both BSCWSD and Yellowstone Club wastewater treatment facilities, could be utilized for snowmaking on Eglise Ridge. The recently constructed pond at Spanish Peaks, which receives treated wastewater from BSCWSD, could potentially be utilized for snowmaking at Big Sky Resort. Similarly, wastewater from Moonlight Basin’s treatment facilities could be utilized for snowmaking on ski terrain in the Jack Creek watershed. Additional storage ponds and pipelines will be required for Big Sky Resort to fully implement the envisioned snowmaking program. Managing storage pond filling and water levels will also be required to ensure there is enough water at the right times of year to perform snowmaking, while also ensuring that summer irrigation needs are met.

Challenges facing Developing Water Reuse for Snowmaking in the Big Sky area include:

- Not currently used in Montana, so will require development of program
- Fragmented management between entities

- Required level of treatment to ensure no negative effect to the ecological health of river systems is unknown
- Implementation by 2020 would be at existing levels of treatment
- Lack of existing infrastructure to provide treated wastewater for snowmaking on ski runs
- Requires storage in ponds and coordination with summer irrigation needs
- Storage ponds require periodic maintenance and can be subject to failures
- Runoff of treated water may degrade shallow groundwater and surface water quality
- Climate and weather pattern variability could impact the length of the season when this technique can be utilized

Policies, Regulations and Laws relevant to Developing Water Reuse for Snowmaking include DEQ Circular-2 Appendix B. Snowmaking with treated wastewater effluent has not previously been conducted in Montana and will require a MPDES discharge permit under existing regulations. Developing the regulatory framework in partnership with DEQ will be required to establish this form of wastewater reuse to ensure nutrient inputs don't negatively impact the ecological health of the river systems. There are nutrient TMDLs for Middle Fork West Fork Gallatin River, South Fork West Fork Gallatin River and West Fork Gallatin River, so reclaimed water used for snowmaking will need to be treated to a high level so that nutrient concentrations do not increase. In addition, once surface water rights are no longer required for snowmaking, there is the potential to convert or lease these water rights to instream flow rights, which would benefit the ecological health of the river systems by maintaining more water in stream during the winter timeframe when fish are stressed and there is a high level of mortality due to ice formation.

Economics and Cost Considerations for Developing Water Reuse for Snowmaking include costs for installing the infrastructure to pipe water from the BSCWSD wastewater treatment plant to storage ponds at Yellowstone Club, Spanish Peaks, and Big Sky Resort, along with significant energy and labor requirements to run the snowmaking equipment. Providing wastewater treatment in the Mountain Village could alleviate the need to pump water up from the existing site of treatment in the Meadow Village. Snowmaking is currently occurring during the early part of the ski season at Big Sky Resort and Yellowstone Club, and additional water may provide the opportunity to expand the downhill ski season at these resorts, along with the cross-country ski season at Lone Mountain Ranch. Over the long-term, maintaining the foundation of the recreation-based economy by ensuring there is snow at Big Sky area ski resorts will be beneficial.

Community Interest and Support for Developing Water Reuse for Snowmaking is strong, though there is potentially a negative public perception to skiing on snow created from reclaimed water. This technique is being applied at other ski areas in the United States, which could provide guidance on how to successfully address the concerns of the skiing public. Among the two downhill ski area operators, Big Sky Resort and the Yellowstone Club support snowmaking with treated wastewater as a tool for alleviating potential decreases to snowpack due to future climate variability and have expressed interest in implementing this program by 2020. Among downstream agricultural water users, activities which hold water in the form of snow in the mountains longer and provide for increased water in the rivers during the late-summer when irrigation demands are highest are generally viewed favorably.

Potential Partner Organizations for Developing Water Reuse for Snowmaking include BSCWSD, Yellowstone Club, Spanish Peaks, Big Sky Resort, Moonlight Basin, and Lone Mountain Ranch, along with the Task Force, MCD, MBMG, GLWQD, TU and DEQ.

2.3.5 Investigate Shallow Groundwater Recharge

The purpose of **Investigating Shallow Groundwater Recharge** is to:

- Provide for aquifer recharge to support late-season streamflows
- “Slow the flow” of water within the watershed
- Add resiliency to water systems in drought condition, especially to augment late-season streamflow during baseflow conditions
- Add another beneficial use alternative for reuse of treated wastewater
- Augmentation could occur during higher seasonal use, which could help alleviate storage issues

Shallow groundwater recharge uses treated wastewater effluent or stormwater and directly injects it, typically without further soil percolation, to augment an existing groundwater resource. This can be accomplished through several types of subsurface injection methods. Current potential for use of these technologies is unknown within the Gallatin watershed area of Big Sky, though the upper Jack Creek watershed has been determined not to be suitable for use of this technology.

Technical considerations for Investigating Shallow Groundwater Recharge include:

- Complex geology and recharge regimes that require more characterization
 - On the Gallatin side, there are sand and gravel aquifers that may be suitable
- Lack of flat land
 - The Big Sky area has many steep slopes and landslide prone areas that would be unsuitable for additional water loading
- Ongoing measuring and monitoring requirements
- Potential to degrade groundwater resources if treatment levels are not sufficient
- Ties into *Montana State Water Plan* (DNRC 2015) for aquifer recharge, which promotes recharge in natural floodplains and riparian areas

Policies, Regulations and Laws relevant to Investigating Shallow Groundwater Recharge include permitting requirements under the Montana Water Quality Act (§75-5-605). Relative to water rights mitigation, the reuse of treated wastewater through groundwater recharge is not consumptive and could be used for mitigation.

Economics and Cost Considerations for Investigating Shallow Groundwater Recharge include aquifer conditions, with economic feasibility increasing in areas with higher potential rates of recharge. For BSCWSD, third party agreements would likely be needed to build and maintain groundwater recharge infrastructure. In addition, if land would need to be purchased, it could sharply raise the cost of this alternative.

Community Interest and Support for Investigating Shallow Groundwater Recharge is positive.

Potential Partner Organizations for Investigating Shallow Groundwater Recharge include BSCWSD, Yellowstone Club, Spanish Peaks, Big Sky Resort, Moonlight Basin and other private landowners, along with the Task Force, MCD, MBMG, GLWQD, TU and DEQ.

2.4 ALTERNATIVES ANALYSIS FOR AREAS THAT DID NOT RECEIVE CONSENSUS

In addition to the five areas of consensus for Wastewater Treatment and Reuse, Water Forum stakeholders were unable to reach consensus in two areas:

1. Direct Discharge of Treated Wastewater to the River Systems
2. Direct and/or Indirect Potable Reuse

Stakeholders discussed the pros and cons of directly discharging treated wastewater effluent into the river systems and the potential for direct or indirect potable reuse, but were unable to reach consensus on where or if these two reuse alternatives should be included on the list of priorities outlined within this watershed stewardship plan. In addition to stakeholder discussions, there were numerous comments opposed to direct surface water discharge in the responses provided to the community survey conducted in August and September of 2017 (**Appendix E**). Water Forum stakeholders did agree that either of these two reuse alternatives would need to meet the vision of the Water Forum and the goals and objectives identified for each of the three water resources focus areas (**Section 1.3**).

Water Forum stakeholders affirmed that direct discharge of treated wastewater effluent to the river systems would need to provide an ecological benefit and result in no negative impacts to the river systems. However, many Water Forum stakeholders felt there were unanswered questions that would need to be answered before a final determination on the alternative of direct discharge could be made (**Appendix I**). Potential ecological benefits of directly discharging treated wastewater effluent into the river systems identified by Water Forum stakeholders include:

- Increased streamflows during low-flow periods
- Thermally conditioning the water to provide cooler water during times when stream temperatures exceed 65°F

Water Forum stakeholder concerns with directly discharging treated wastewater effluent to the river systems include potential negative economic impacts and negative impacts to the river systems, including degradation of:

- Water quality
- Fisheries
- Aesthetics
- Recreational experience

For direct and/or indirect potable reuse, most factors associated with this reuse alternative are unknown and no detailed analysis has been conducted. Potable reuse has not been implemented in Montana, so it is unclear what regulatory changes might be needed.

Moving forward, several action items are being pursued that will address unanswered questions about potential beneficial reuse alternatives. Specifically, BSCWSD is undertaking an analysis of plant upgrades and infrastructure improvements associated with direct surface water discharge. Analysis from this work, slated for 2018, will help answer questions about feasibility, cost and potential ecological impacts or benefits for the river system. In addition, expanded water quality monitoring outlined in this watershed stewardship plan will provide additional baseline data to inform management decisions and engage the community in further discussions on appropriate reuse alternatives for treated wastewater.

3.0 IMPLEMENTATION PLAN

This watershed stewardship plan is the first step towards improving management of the Big Sky area's water resources. Implementation of the actions prioritized by the Water Forum stakeholder group will require long-term engagement of the stakeholders and the Big Sky area community.

3.1 CAPACITY FOR IMPLEMENTATION

The actions identified in this watershed stewardship plan will require additional capacity, coordination and resources to implement the Water Forum stakeholder's recommendations.

Three major resource needs were identified:

- 1) Partnerships between landowners, non-profit organizations, businesses and agencies
- 2) Funding to support the necessary staff and project costs
- 3) Coordinating entity or contractor

3.1.1 Partnerships for Watershed Stewardship Plan Implementation

The management of the Big Sky area's water resources is fragmented across political, watershed, and ownership boundaries. In addition, water resources management requires interaction with partners in the zone of influence within the Madison and Gallatin watersheds and with agency personnel based outside of the Big Sky area. Additionally, the recommended actions within each of the three water resources focus areas vary greatly in scale and complexity. Because of these factors, different types and sets of partners will need to interact to implement this watershed stewardship plan.

Types of partners identified are:

- Individual landowners that manage their land and water resources, including landowners that manage their septic systems and landowners that participate in conservation easements and wetland and riparian enhancement.
- Non-profit partners with specific water resources expertise include conservation organizations, agricultural advocates, and local community entities. These entities conduct on-the-ground restoration and conservation activities, monitoring, and education and outreach.
- Business partners that own or manage specific parcels of land or provide services that affect water resources management. These include developers, wastewater treatment system operators and landscape managers.
- Government partners who have jurisdiction and oversight for water resources management. Partners of this type include local, county, state and federal agencies.

Water Forum stakeholders identified potential roles their entities can play in the implementation of this watershed stewardship plan, which are presented in **Table 3-1** and found in **Section 2.0** for the alternatives analyzed in each of the three water resources focus areas. As implementation of this watershed stewardship plan proceeds, additional partners may be identified.

Table 3-1. Potential Partners for Implementation within each of the Three Focus Areas

Focus Area	Lead Partners	Additional Partners	Review
Ecological Health of River Systems			
Watershed Status and Trends Monitoring Program	GRTF, MCD, GLWQD, FWP	MBMG, DEQ, YC, DNRC, MSU, GYC, Big Sky Trout, Gallatin Health	YC, BSOA, Gallatin Planning
Watershed Status and Trends Dashboard	GRTF, MCD, GLWQD, FWP	MBMG, YC, DNRC, Big Sky Trout, Gallatin Health	YC, BSOA, GYC
Watershed Restoration and Conservation	GRTF, MCD, MLR	TU, MBMG, YC, DNRC, BSOA, BSCO, GYC, GLWQD, Big Sky Trout	YC, BSOA, DNRC
Water Supply and Availability			
Groundwater Monitoring and Modeling	MBMG, GLWQD, BSCWSD	DNRC, GRTF, MCD	YC, BSOA, GYC, Big Sky Trout, Madison Planning
Outreach and Incentives for Water Conservation	GRTF, BSCWSD, YC	TU, BSOA, DNRC, GLWQD, MCD, Moonlight	YC, GYC, Big Sky Trout
Stormwater Management	GRTF, BSCSWD, DEQ	BSOA, Gallatin Planning	YC, BSOA, DNRC, GLWQD, MCD, GYC, UMW, Madison Planning, Big Sky Trout
Mitigation of Water Rights	DNRC	TU, YC, AGAI, FWP, MARS, Gallatin Planning	BSOA, GRTF, GLWQD, MCD
Wastewater Treatment and Reuse			
High Treatment Levels for Treated Wastewater	BSCWSD, YC, Moonlight, DEQ	MCD, GYC, AR, Gallatin Health, Gallatin Planning, Chamber	GRTF, DNRC, UMW, Madison Planning, Big Sky Trout
Address Septic Systems and Small Community Systems	GLWQD	BSCWSD, GRTF, MCD, GYC, AR, Gallatin Health, Gallatin Planning, Chamber	YC, DNRC, UMW, Madison Planning, Big Sky Trout
Expand Water Reuse for Irrigation	YC, BSCWSD, BSR, Moonlight, DEQ	TU, DNRC, BSCO, MCD, AR, Gallatin Health, Chamber	GRTF, GYC, UMW, Big Sky Trout
Develop Water Reuse for Snowmaking	BSCWSD, YC, BSR, Moonlight, DEQ	TU, DNRC, MCD, GYC, AR	GRTF, UMW, Big Sky Trout
Shallow Groundwater Recharge	BSCWSD, YC, BSR, DEQ	TU, DNRC, MCD, GYC	GRTF, UMW, Big Sky Trout

3.1.2 Partnership Structures for Continuing Collaboration

The recommended actions in this watershed stewardship plan vary among the three water resources focus areas, but most require more than one entity to implement due to the fragmented nature of the political, watershed and geographic boundaries within the Big Sky area.

The types of partnership structures necessary to implement the recommendations within this watershed stewardship plan include:

- One or two entities lead implementation and others play a supporting role to ensure action is completed
- Multiple entities with expertise meet to solve problems, then one or a few entities implement
- Lead entities develop and implement, with community input
- Requires multiple entities to develop and coordinate work together

Water Forum stakeholders identified two specific needs to support implementation:

- **Information sharing and coordination:** The Water Forum stakeholders are clear on identified action items for implementation, but there are data gaps and a need to include more partners in the future. Thus, an ongoing structure to coordinate activities is important.
- **Developing specific priority areas and projects:** Developing recommended wastewater reuse alternatives and expanding the groundwater and surface water monitoring network were identified as areas that require specific, multi-disciplinary collaboration for successful implementation. These will likely need development work for a specific period of time before one or a handful of partners can implement further work.

To meet these two needs, an umbrella “Headwaters Alliance” with a coordinator, steering committee, community partnerships, and working groups is proposed as an implementation framework. The “Headwaters Alliance” concept is presented in **Figure 3-1** and includes:

- Community Partnerships:
 - Steering committee to facilitate communication between partners and the community
 - Funding committee to establish initial capacity and develop a sustained funding source
 - Individual septic systems and public community systems committee
 - Ongoing coordination and increased organizational capacity
- Working Groups:
 - Monitoring committee to establish a Sampling and Analysis Plan (SAP) to expand the monitoring network to meet the priorities of this watershed stewardship plan
 - Irrigation reuse committee to establish modern greenspace management and to identify priority areas for expansion
 - Snowmaking reuse committee to work through the treatment, technical, legal, permitting, infrastructure, and community engagement issues

In addition to this framework for implementation, a Memorandum of Understanding (MOU) or good neighbor agreement focused on specific actions around reuse alternatives development with specific partners could be useful.

Implementation: “Headwaters Alliance”

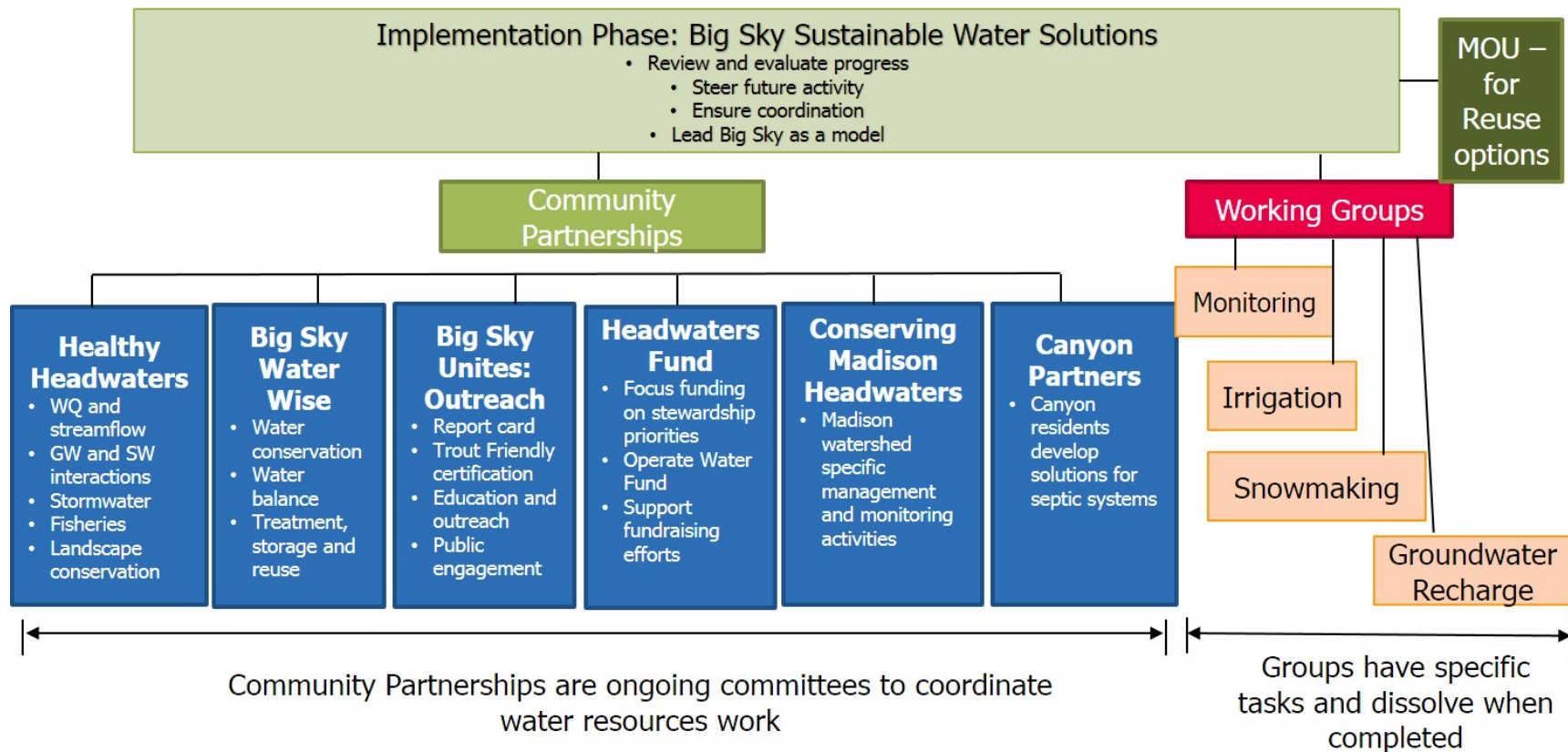


Figure 3-1. Watershed Stewardship Plan Implementation Framework

3.1.3 Funding for Watershed Stewardship Plan Implementation

To complete the recommended actions on the timeline proposed by Water Forum stakeholders, organizational capacity must be increased. If fewer human and funding resources are available, it is likely that implementation of this watershed stewardship plan will proceed more slowly than desired.

Three types of capacity will be needed to implement this watershed stewardship plan:

Specific Grants and Bonds: Grant funds from local, state, federal and private funding mechanisms are useful for launching and sustaining certain functions and funding specific restoration, conservation and infrastructure improvement projects. In the Big Sky area, Resort Tax, Madison and Gallatin counties, State agencies, foundations, and private entities, among others, have provided funding for water resources monitoring, management, infrastructure and coordination. State grants and rate-payer approved bonds have been used to improve water supply and wastewater treatment and reuse infrastructure. State, federal and private grants and donations are useful for launching new activities and for funding specific restoration and conservation projects.

Operational and Capital Budgets: Businesses, agencies and public works departments have budgets and future revenue streams that can be used to support recommended actions. In several cases, local entities are already directing funds toward recommended priorities and actions. These include fisheries management, recreation management, surface water monitoring, and groundwater monitoring, along with water supply and wastewater treatment and reuse within the BSCWSD, Yellowstone Club, and Moonlight Basin.

Long-Term Funding Mechanisms for Water Services: Several identified actions need to continue indefinitely, but do not have an established organizational budget. These actions include most groundwater and surface water monitoring, coordination between partners, community engagement, and implementation of specific restoration and conservation projects. Establishing a permanent funding mechanism is one way to fund services for the long-term. A Water Fund is one option for sustaining long-term funding that can be used to fund water services. Water Funds have been developed by The Nature Conservancy around the world and provide a funding mechanism that can be used across jurisdictions to improve water resources. Establishment of a Water Fund will require significant start-up resources, but experience in other localities suggest this approach could fill existing gaps in funding. Special Improvement Districts (SID) or Rural Improvement Districts (RID) could be established in the longer term as well.

To implement this watershed stewardship plan, funding for staffing, expertise and project implementation will be needed. **Table 3-2** presents a range of funding needs for watershed stewardship plan implementation. Funding needs are estimated for each of the three water resources focus areas based on action items discussed in the following sections. Funding ranges of \$0-100,000, \$100,000-\$500,000, \$500,000-\$1,000,000 and \$1,000,000+ are presented for quick start activities over the first year and then in five-year increments covering the short and mid-terms through 2028. Long-term funding needs will be re-evaluated as components of this watershed stewardship plan are implemented.

Table 3-2. Estimated Funding Requirements for Watershed Stewardship Plan Implementation

Focus Area	Quick Start (2018) (1 Year)	Short-term (2019-2023) (5 Years)	Mid-term (2024-2028) (5 Years)	Long-term (2029+) (5+ Years)
Ecological Health of River Systems				
Watershed Status and Trends Monitoring Program	0-100	500-1,000	500-1,000	500-1,000
Watershed Status and Trends Dashboard	0-100	500-1,000	0-100	0-100
Watershed Restoration and Conservation	0-100	500-1,000	1,000+	1,000+
Water Supply and Availability				
Groundwater Monitoring and Modeling	0-100	100-500	100-500	100-500
Strategies for Water Conservation	0-100	100-500	100-500	100-500
Stormwater Management	0-100	100-500	100-500	1,000+
Mitigation of Water Rights	0	0-100	100-500	100-500
Wastewater Treatment and Reuse				
High Treatment Levels for Treated Wastewater	0-100	1,000+	1,000+	1,000+
Address Septic Systems and Small Community Systems	0-100	100-500	100-500	1,000+
Expand Water Reuse for Irrigation	0-100	500-1,000	500-1,000	100-500
Develop Water Reuse for Snowmaking	0-100	1,000+	1,000+	1,000+
Investigate Shallow Groundwater Recharge	0	0-100	0-100	100-500
Total	0-1,000	4,400-8,200+	4,500-7,700+	6,000-8,600+
Annual	0-1,000	880-1,640+	900-1,540+	1,200-1,720+
Funding requirements estimated in dollars x1,000	0-100	100-500	500-1,000	1,000+

3.2 ACTION ITEMS FOR ECOLOGICAL HEALTH OF RIVER SYSTEMS

Specific actions identified for Ecological Health of River Systems over the next 10-year period include actions in three areas as follows:

- 1) Watershed Status and Trends Monitoring Program
- 2) Watershed Status and Trends Dashboard
- 3) Watershed Restoration and Conservation

3.2.1 Action Items – Watershed Status and Trends Monitoring Program

To establish the Watershed Status and Trend Monitoring Program, an expanded water quality monitoring network will be developed to track water quality trends, fill identified data gaps, provide baseline information for permitting actions, and identify areas for restoration and conservation activities. Both surface water and groundwater monitoring will be included, along with assessments of streamflows, groundwater and surface water interactions, wetland and riparian areas, instream habitat and fisheries. Quick start actions to initiate the Watershed Status and Trend Monitoring Program in 2018 include expanded water quality monitoring, streamflow monitoring, and riparian and wetland assessments. This will require development of a Sampling and Analysis Plan (SAP) and Quality Assurance Project Plan (QAPP). Quick start actions also include establishing a long-term funding source to sustain the Watershed Status and Trend Monitoring Program. Within the short-term, this program will be expanded to include the suite of parameters identified in **Section 2.2.1** and **2.2.2**. Data will be analyzed annually and used to develop the Watershed Status and Trend Monitoring Dashboard, identify appropriate “target” or “trigger” values, and document ecological improvements over the long-term. As a robust ecological dataset is developed for the Big Sky area, the data will be used to adapt the monitoring program into the mid-and-long terms as needed.

A summary of actions during the next 10 years for the Watershed Status and Trend Monitoring Program include the following, which are also presented in **Table 3-3**:

Quick Start (2018)

- Develop expanded monitoring program (includes monitoring for all three water resources focus areas)
- Develop technical advisory committee
- Develop SAP/QAPP for expanded monitoring program for trends monitoring, filling data gaps, future permitting, and identifying areas for restoration and conservation
- Initiate expanded monitoring program
- Monitoring data analysis and reporting
- Establish funding plan for Years 1-3

Short-term (2019-2023)

- Continue expanded monitoring program, adapt as needed to track water quality trends, fill identified data gaps, provide baseline information for permitting actions, and identify areas for restoration and conservation activities
- Update SAP/QAPP as needed
- Monitoring data analysis and reporting
- Establish long-term funding mechanism

Mid-to-Long-term (2024-2029+)

- Continue expanded monitoring program, adapt as needed
- Update SAP/QAPP as needed
- Monitoring data analysis and reporting
- Maintain long-term funding mechanism
- Utilize data to document ecological improvements and guide future restoration and conservation activities

Table 3-3. Implementation Action Items for Watershed Status and Trends Monitoring Program

Watershed Status and Trends Monitoring Program			
Quick Start (2018)	Short-term (2019-2023)	Mid-term (2024-2028)	Long-term (2029+)
Develop expanded monitoring program (includes monitoring for all three water resources focus areas); initiate expanded monitoring program	Continue expanded monitoring program, adapt as needed to track water quality trends, fill identified data gaps, provide baseline information for permitting actions, and identify areas for restoration and conservation activities	Continue expanded monitoring program, adapt as needed	Continue expanded monitoring program, adapt as needed
Develop technical advisory committee			
Develop SAP/QAPP for expanded monitoring program for trends monitoring, filling data gaps, future permitting, and identifying areas for restoration and conservation	Update SAP/QAPP as needed	Update SAP/QAPP as needed	Update SAP/QAPP as needed
Monitoring data analysis and reporting	Monitoring data analysis and reporting	Monitoring data analysis and reporting	Monitoring data analysis and reporting
Establish funding plan for Years 1-3	Establish long-term funding mechanism	Maintain long-term funding mechanism	Maintain long-term funding mechanism
		Utilize data to document ecological improvements and guide future restoration and conservation activities	Continue to utilize data to document ecological improvements and guide future restoration and conservation activities

3.2.2 Action Items – Watershed Status and Trends Dashboard

The Watershed Status and Trends Dashboard will be used to convey information collected in the Watershed Status and Trends Program. As a quick start action, environmental indicators will be established, and monitoring parameters will be selected to assess changes in the environmental indicators and to convey the results of monitoring to the community. In the short-term, the Watershed Status and Trends Dashboard will be created, with both an electronic online version and a physical structure to be placed somewhere in the Big Sky area. In the short-term, environmental “targets” or “triggers” will be developed that are specific and relevant to the streams of the Big Sky area. The environmental “target” or “trigger” levels will identify a set of recommended actions to be taken when a “target” or “trigger” value is exceeded and identify which entity is responsible for the action. Thus, the Watershed Status and Trends Dashboard will be used as a tool to engage water resource managers in the short-term and provide for adaptive management of water resources in the mid-to-long term. As the Watershed Status and Trends Dashboard is developed and embraced by the Big Sky area community, additional measures regarding water supply and wastewater treatment will also be added. Over the long-term, the Watershed Status and Trends Dashboard will provide water resources managers and the Big Sky community the ability to evaluate monitoring data relative to “targets” or “triggers” for established environmental indicators to document ecological improvements resulting from restoration, conservation and management actions.

A summary of actions during the next 10 years for the Watershed Status and Trend Monitoring Dashboard include the following, which are also presented in **Table 3-4**:

Quick Start (2018)

- Establish environmental indicators and monitoring parameters

Short-term (2019-2023)

- Develop dashboard based on established environmental indicators, including online and in-town; update dashboard with monitoring data
- Develop communication and outreach plan
- Engage water resources managers on utilization of trend data for decision making
- Develop “targets” or “triggers” based on established environmental indicators
- Establish long-term funding mechanism

Mid-to-Long-term (2024-2029+)

- Continue to update dashboard with monitoring data; provide analysis and explain implications
- Use dashboard for adaptive management of water resources
- Use “targets” or “triggers” for established environmental indicators to document ecological improvements resulting from restoration, conservation and management actions
- Maintain long-term funding mechanism

Table 3-4. Implementation Action Items for Watershed Status and Trends Dashboard

Watershed Status and Trends Dashboard			
Quick Start (2018)	Short-term (2019-2023)	Mid-term (2024-2028)	Long-term (2029+)
Establish environmental indicators and monitoring parameters	Develop dashboard based on established environmental indicators, including online and in-town; update dashboard with monitoring data	Continue to update dashboard with monitoring data; provide analysis and explain implications	Continue to update dashboard with monitoring data; provide analysis and explain implications
	Engage water resources managers on utilization of trend data for decision making	Use dashboard for adaptive management of water resources	Use dashboard for adaptive management of water resources
	Develop "targets" or "triggers" based on established environmental indicators	Use "targets" or "triggers" for established environmental indicators to document ecological improvements resulting from restoration, conservation and management actions	Continue to use "targets" or "triggers" for established environmental indicators to document ecological improvements resulting from restoration, conservation and management actions
	Establish long-term funding mechanism	Maintain long-term funding mechanism	Maintain long-term funding mechanism

3.2.3 Action Items – Watershed Restoration and Conservation

Watershed Restoration and Conservation will entail addressing existing water quality impairments and protecting the existing high-quality water resources by maintaining connectivity in the hydrologic and biologic systems of the Big Sky area. Quick start actions include identifying priority projects, identifying partners, seeking funding sources, updating the *Upper Gallatin River Watershed Restoration Plan (WRP)*, and documenting restoration and conservation actions and measurable outcomes already completed. To identify the existing high value riparian corridors and wetland resources, riparian and wetland mapping and on-the-ground assessments are a short-term priority, along with evaluating existing instream habitat and determining the existing presence and abundance of both wild and native fish. This information will provide the foundation for implementing restoration and conservation projects over the short-to-long term, with an emphasis on restoring and conserving high-value wetland and riparian corridors, maintaining natural disturbance regimes that support dynamic instream habitat, enhancing fisheries, and improving water quality. Identifying a sustainable source of funding to implement restoration and conservation actions will be necessary. Documenting restoration and conservation actions already taken and underway will be beneficial when seeking additional funding.

A summary of actions during the next 10 years for Watershed Restoration and Conservation include the following, which are also presented in **Table 3-5**:

Quick Start (2018)

- Identify projects to prioritize from existing plans
- Identify partners to pursue implementation of specific projects
- Seek funding sources for project implementation
- Update Upper Gallatin River Watershed Restoration Plan for impaired streams
- Document restoration and conservation actions already taken

Short-term (2019-2023)

- Identify projects to prioritize from existing plans and newly collected data; implement restoration and conservation projects
- Continue to seek funding sources for project implementation
- Engage private landowners in conservation activities

Mid-to-Long-term (2024-2029+)

- Continue to implement restoration and conservation projects; utilize monitoring data to prioritize future projects
- Continue to seek funding sources for project implementation
- Continue to engage private landowners in conservation activities

Table 3-5. Implementation Action Items for Watershed Restoration and Conservation

Watershed Restoration and Conservation			
Quick Start (2018)	Short-term (2019-2023)	Mid-term (2024-2028)	Long-term (2029+)
Identify projects to prioritize from existing plans	Identify projects to prioritize from existing plans and newly collected data; implement restoration and conservation projects	Continue to implement restoration and conservation projects; utilize monitoring data to prioritize future projects	Continue to implement restoration and conservation projects; utilize monitoring data to prioritize future projects
Identify partners to pursue implementation of specific projects			
Seek funding sources for project implementation	Continue to seek funding sources for project implementation	Continue to seek funding sources for project implementation	Continue to seek funding sources for project implementation
Update Upper Gallatin River Watershed Restoration Plan for impaired streams			
Document restoration and conservation actions already taken			
	Engage private landowners in conservation activities	Continue to engage private landowners in conservation activities	Continue to engage private landowners in conservation activities

3.3 ACTION ITEMS FOR WATER SUPPLY AND AVAILABILITY

Specific actions identified for Water Supply and Availability over the next 10-year period include actions in five areas as follows:

- 1) Groundwater Monitoring and Modeling
- 2) Strategies for Water Conservation
- 3) Stormwater Management
- 4) Wastewater Reuse
- 5) Mitigation of Water Rights

Actions for Monitoring and Modeling, Strategies for Water Conservation, Stormwater Management, and Mitigation of Water Rights are provided in the following sections, while actions for wastewater reuse alternatives that benefit water supply, including Expanding Water Reuse for Irrigation, Developing Water Reuse for Snowmaking, and Investigating Shallow Groundwater Recharge are discussed in **Sections 3.4.3 through 3.4.5**.

3.3.1 Action Items – Groundwater Monitoring and Modeling

Groundwater Modeling and Monitoring is necessary to accurately characterize the available water supply in the Big Sky area by generating seasonal outlook reports for groundwater supplies, modeling the impacts of various climate scenarios, modeling various withdrawal (pumping) amounts, developing real-time data on groundwater and surface water, and developing a water balance to identify “targets” or “triggers” for action. Groundwater Modeling and Monitoring includes the existing MBMG GWIP groundwater modeling effort for the Meadow Village aquifer and additional future modeling efforts for the Lower Basin (“Canyon”) aquifer, along with expanded monitoring of groundwater wells throughout the Big Sky area. Quick start actions include reviewing the results of the MBMG GWIP Meadow Village aquifer study when completed, instituting protective measures based on the results, developing a plan to continue monitoring at sites established by MBMG, and identifying additional sites for groundwater monitoring. Applying for a MBMG GWIP study of the Lower Basin (“Canyon”) aquifer is a quick start action and, if awarded, the project could be completed in the short-term. Quick start action items also include identifying additional streamflow gauging sites to evaluate groundwater and surface water interactions, particularly in relation to trout spawning habitat in tributary streams and along the Gallatin River upstream and downstream of the confluence with the West Fork Gallatin River. Expanded streamflow, groundwater and precipitation data will be used to refine the water yield estimates developed for the West Fork Gallatin River watershed and to develop water yield analyses and water balances for other watersheds in the Big Sky area. Once established, the expanded groundwater monitoring network will be continued through the short-to-long term and information will be communicated to the community through the Watershed Status and Trends Dashboard.

A summary of actions during the next 10 years for Groundwater Monitoring and Modeling include the following, which are also presented in **Table 3-6**:

Quick Start (2018)

- Identify additional streamflow monitoring sites/gauging stations and groundwater monitoring sites; incorporate into Watershed Status and Trends Monitoring Program SAP/QAPP
- Apply to MBMG GWIP for funding for Lower Basin (“Canyon”) aquifer study

- Review results of MBMG GWIP Meadow Village aquifer study
- Establish funding for Years 1-3

Short-term (2019-2023)

- Implement expanded groundwater and surface water monitoring; provide data in real-time and as updates to Watershed Status and Trends Dashboard
- Conduct Lower Basin (“Canyon”) aquifer study
- Adapt management decisions for Big Sky Golf Course and institute protective measures based on results of Meadow Village aquifer study; add real-time tracking of groundwater elevations and obtain additional soils data
- Establish long-term funding mechanism
- Refine water yield estimates and develop water balance for West Fork watershed; develop water yield and water balance for Jack Creek watershed; use information to manage water use and reuse and to develop “targets” or “triggers” for management actions
- Evaluate exempt well regulations, stream depletion zones, and controlled groundwater areas as potential tools for addressing groundwater withdrawals from individual wells and community systems

Mid-term (2024-2028)

- Continue groundwater and surface water monitoring; expand as needed; provide data in real-time and as updates to Watershed Status and Trends Dashboard
- Adapt management decisions based on results of Lower Basin (“Canyon”) aquifer study; update Canyon Area Wastewater Treatment and Disposal study; identify future groundwater priority areas for assessment
- Adapt management decisions for Big Sky Golf Course based on data; develop seasonal forecasts for groundwater supplies
- Maintain long-term funding mechanism

Long-term (2029+)

- Continue groundwater and surface water monitoring; expand as needed; provide data in real-time and as updates to Watershed Status and Trends Dashboard
- Conduct additional studies in groundwater priority areas
- Continue to adapt management decisions based on data; develop seasonal forecasts for groundwater supplies
- Maintain long-term funding mechanism

Table 3-6. Implementation Action Items for Groundwater Monitoring and Modeling

Groundwater Monitoring and Modeling			
Quick Start (2018)	Short-term (2019-2023)	Mid-term (2024-2028)	Long-term (2029+)
Identify additional streamflow monitoring sites/gauging stations and groundwater monitoring sites; incorporate into Watershed Status and Trends Monitoring Program SAP/QAPP	Implement expanded groundwater and surface water monitoring; provide data in real-time and as updates to Watershed Status and Trends Dashboard	Continue groundwater and surface water monitoring; expand as needed; provide data in real-time and as updates to Watershed Status and Trends Dashboard	Continue groundwater and surface water monitoring; expand as needed; provide data in real-time and as updates to Watershed Status and Trends Dashboard
Apply to MBMG GWIP for funding for Lower Basin ("Canyon") aquifer study	Conduct Lower Basin ("Canyon") aquifer study	Adapt management decisions based on results of Lower Basin ("Canyon") aquifer study; update Canyon Area Wastewater Treatment and Disposal study; identify future groundwater priority areas for assessment	Conduct additional studies in groundwater priority areas
Review results of MBMG GWIP Meadow Village aquifer study	Adapt management decisions for Big Sky Golf Course and institute protective measures based on results of Meadow Village aquifer study; add real-time tracking of groundwater elevations and obtain additional soils data	Adapt management decisions for Big Sky Golf Course based on data; develop seasonal forecasts for groundwater supplies	Continue to adapt management decisions based on data; develop seasonal forecasts for groundwater supplies
Establish funding for Years 1-3	Establish long-term funding mechanism	Maintain long-term funding mechanism	Maintain long-term funding mechanism

Groundwater Monitoring and Modeling			
Quick Start (2018)	Short-term (2019-2023)	Mid-term (2024-2028)	Long-term (2029+)
	Refine water yield estimates and develop water balance for West Fork watershed; develop water yield and water balance for Jack Creek watershed; use information to manage water use and reuse and to develop "targets" or "triggers" for management actions		
	Evaluate exempt well regulations, stream depletion zones, and controlled groundwater areas as potential tools for addressing groundwater withdrawals from individual wells and community systems		

3.3.2 Action Items – Strategies for Water Conservation

Strategies for Water Conservation aims to inspire and/or require community members to actively engage in water conservation strategies that reduce groundwater withdrawals, maintain instream flows, and build resilience against changing climate conditions. Snow on the mountain and water in the river drives the Big Sky economy and water conservation is a community partnership that needs all water users working together to succeed. To establish Strategies for Water Conservation, quick start and short-term actions include outreach to developers, HOAs, and municipal water users on conservation practices, along with the continuation of the Task Forces' Big Sky Water Conservation rebate program. These activities are envisioned to be continued through the mid-to-long term. In addition, identifying a short to-long-term funding source for water conservation is a quick start action. In the short-term, Moonlight Basin plans to develop a tracking system for existing water meters and expand water metering into newly developed areas. In the short-term, the expansion of irrigation use of reclaimed water delivered through purple pipes will be documented and opportunities to develop grey water reuse projects will be explored. Where possible, opportunities to reduce water supply demands by retiring existing development rights will also be explored. Utilizing regulations to enforce conservation through zoning, building codes, architectural review, subdivision review, landscaping requirements, and controlled groundwater area designation will also be explored, including the development of a landscape design and irrigation ordinance for the BSCWSD that outlines new water efficient specifications.

A summary of actions during the next 10 years for the Strategies for Water Conservation include the following, which are also presented in **Table 3-7**:

Quick Start (2018)

- Outreach to HOAs and community on conservation practices
- Outreach on the Task Forces' Big Sky Water Conservation rebate program
- Develop landscape design and irrigation ordinance for BSCWSD that outlines new water efficient specifications
- Investigate potential changes to existing covenants, regulations and zoning
- Identify short and long-term funding sources

Short-term (2019-2023)

- Continue outreach to HOAs and community on conservation practices
- Continue the Task Forces' Big Sky Water Conservation rebate program
- Implement landscape design and irrigation ordinance for BSCWSD that outlines new water efficient specifications
- Utilize regulations to enforce conservation (zoning, building codes, architectural review, subdivision review, landscaping requirements, controlled groundwater area)
- Establish long-term funding mechanism
- Document expanded irrigation reuse through purple pipe hook ups
- Document water savings from residential participants of Big Sky Water Conservation rebate program
- Expand Big Sky Water Conservation Program to include incentive options for commercial/municipal water users
- Develop xeriscaping demonstration projects to showcase waterwise landscape design options

- Moonlight Basin: expand water metering
- Identify opportunities for grey water reuse projects
- Reduce water supply demands by retirement of existing development rights

Mid-to-Long-term (2024-2029+)

- Continue the Task Forces' Big Sky Water Conservation rebate program
- Utilize regulations to enforce conservation (zoning, building codes, architectural review, subdivision review, landscaping requirements, controlled groundwater area)
- Establish long-term funding mechanism
- Continue to document expanded irrigation reuse through purple pipe hook ups
- Continue to document water savings from residential participants of Big Sky Water Conservation rebate program
- Continue to expand Big Sky Water Conservation Program
- Implement grey water reuse project
- Continue to reduce water supply demands by retirement of existing development rights

Table 3-7. Implementation Action Items for Strategies for Water Conservation

Strategies for Water Conservation			
Quick Start (2018)	Short-term (2019-2023)	Mid-term (2024-2028)	Long-term (2029+)
Outreach to HOAs and community on conservation practices	Continue outreach to HOAs and community on conservation practices		
Outreach on the Task Forces' Big Sky Water Conservation rebate program	Continue the Task Forces' Big Sky Water Conservation rebate program	Continue the Task Forces' Big Sky Water Conservation rebate program	Continue the Task Forces' Big Sky Water Conservation rebate program
Develop landscape design and irrigation ordinance for BSCWSD that outlines new water efficient specifications	Implement landscape design and irrigation ordinance for BSCWSD that outlines new water efficient specifications		
Investigate potential changes to existing covenants, regulations and zoning	Utilize regulations to enforce conservation (zoning, building codes, architectural review, subdivision review, landscaping requirements, controlled groundwater area)	Utilize regulations to enforce conservation (zoning, building codes, architectural review, subdivision review, landscaping requirements, controlled groundwater area)	Utilize regulations to enforce conservation (zoning, building codes, architectural review, subdivision review, landscaping requirements, controlled groundwater area)
Identify short and long-term funding sources	Establish long-term funding mechanism	Establish long-term funding mechanism	Establish long-term funding mechanism
	Document expanded irrigation reuse through purple pipe hook ups	Continue to document expanded irrigation reuse through purple pipe hook ups	Continue to document expanded irrigation reuse through purple pipe hook ups
	Document water savings from residential participants of Big Sky Water Conservation rebate program	Continue to document water savings from residential participants of Big Sky Water Conservation rebate program	Continue to document water savings from residential participants of Big Sky Water Conservation rebate program

Strategies for Water Conservation			
Quick Start (2018)	Short-term (2019-2023)	Mid-term (2024-2028)	Long-term (2029+)
	Expand Big Sky Water Conservation Program to include incentive options for commercial/municipal water users	Continue to expand Big Sky Water Conservation Program	Continue to expand Big Sky Water Conservation Program
	Develop xeriscaping demonstration projects to showcase waterwise landscape design options		
	Moonlight Basin: expand water metering		
	Identify opportunities for grey water reuse projects	Implement grey water reuse project	
	Reduce water supply demands by retirement of existing development rights	Continue to reduce water supply demands by retirement of existing development rights	Continue to reduce water supply demands by retirement of existing development rights

3.3.3 Action Items – Stormwater Management

As more of the Gallatin River and Madison River watersheds are converted from native vegetation cover to pavement and rooftops, slowing the flow of water through the hydrologic system by improving stormwater management will provide for aquifer recharge and increased late-season streamflows, while also providing resiliency for changing climate conditions. Quick start actions for Stormwater Management include initiating an inventory of existing stormwater outfalls and identifying areas where improved stormwater management is needed. In the short-term, this inventory will be completed, stormwater flow will be modeled, and areas for developing new stormwater infrastructure will be identified. In the short-term, the linkage between stormwater runoff and sediment TMDLs will be evaluated. Actions to address sediment TMDLs by improving stormwater infrastructure will be conducted in the mid-term. An investigation of the merits of establishing a MS4 designation will be conducted in the short-term in conjunction with the development of an area-wide stormwater management plan for the Big Sky area, which will be implemented in the mid-to-long term. Developing “green” infrastructure to manage non-point source runoff and manage stormwater both during construction and post-construction will also be an important component over the long-term.

A summary of actions during the next 10 years for Stormwater Management include the following, which are also presented in **Table 3-8**:

Quick Start (2018)

- Initiate inventory of existing stormwater outfalls and identify areas where needed
- Outreach to developers and HOAs on instituting Best Management Practices (BMPs); spot check construction sites for compliance with BMPs
- Establish funding sources

Short-term (2019-2023)

- Complete inventory of existing stormwater outfalls, model stormwater flows, and identify areas where infrastructure improvements are needed
- Continue outreach to developers and HOAs on instituting BMPs; spot check construction sites for compliance with BMPs
- Maintain funding sources
- Investigate MS4 designation and/or develop stormwater management plan
- Identify linkages between stormwater and sediment TMDLs

Mid-to-Long-term (2024-2029+)

- Implement stormwater infrastructure improvements
- Continue outreach to developers and HOAs on instituting BMPs; spot check construction sites for compliance with BMPs
- Maintain funding sources
- Implement stormwater management plan; adapt as needed
- Address sediment TMDLs by improving stormwater infrastructure

Table 3-8. Implementation Action Items for Stormwater Management

Stormwater Management			
Quick Start (2018)	Short-term (2019-2023)	Mid-term (2024-2028)	Long-term (2029+)
Initiate inventory of existing stormwater outfalls and identify areas where needed	Complete inventory of existing stormwater outfalls, model stormwater flow, and identify areas where infrastructure improvements are needed	Implement stormwater infrastructure improvements	Continue to implement stormwater infrastructure improvements
Outreach to developers and HOAs on instituting BMPs; spot check construction sites for compliance with BMPs	Continue outreach to developers and HOAs on instituting BMPs; spot check construction sites for compliance with BMPs	Continue outreach to developers and HOAs on instituting BMPs; spot check construction sites for compliance with BMPs	Continue outreach to developers and HOAs on instituting BMPs; spot check construction sites for compliance with BMPs
Establish funding sources	Maintain funding sources	Maintain funding sources	Maintain funding sources
	Investigate MS4 designation and/or develop stormwater management plan	Implement stormwater management plan; adapt as needed	Continue to implement stormwater management plan; adapt as needed
	Identify linkages between stormwater and sediment TMDLs	Address sediment TMDLs by improving stormwater infrastructure	Continue to address sediment TMDLs by improving stormwater infrastructure

3.3.4 Action Items – Mitigation of Water Rights

Mitigation of Water Rights is an option to be developed over the long-term. However, steps in the nearer-term may be beneficial, including maintaining an open dialog with DNRC and senior water rights holders on water rights adjudication, modifications to the change process, and the potential implications of mitigation. Evaluating existing streamflows relative to FWP instream flow reservations and the relationship between groundwater and surface water interactions would be beneficial.

A summary of actions during the next 10 years for the Mitigation of Water Rights include the following, which are also presented in **Table 3-9**:

Short-to-Long-term (2019-2029+)

- Evaluate "physical availability" vs. "legal availability"
- Evaluate implications to senior water rights holders
- Evaluate existing streamflows relative to FWP instream flow reservations and the relationship between groundwater and surface water interactions

Table 3-9. Implementation Action Items for Mitigation of Water Rights

Mitigation of Water Rights			
Quick Start (2018)	Short-term (2019-2023)	Mid-term (2024-2028)	Long-term (2029+)
	Evaluate "physical availability" vs. "legal availability"	Continue to evaluate "physical availability" vs. "legal availability"	Continue to evaluate "physical availability" vs. "legal availability"
	Evaluate implications to senior water rights holders	Continue to evaluate implications to senior water rights holders	Continue to evaluate implications to senior water rights holders
	Evaluate existing streamflows relative to FWP instream flow reservations and the relationship between groundwater and surface water interactions	Continue to evaluate existing streamflows relative to FWP instream flow reservations and the relationship between groundwater and surface water interactions	Continue to evaluate existing streamflows relative to FWP instream flow reservations and the relationship between groundwater and surface water interactions

3.4 ACTION ITEMS FOR WASTEWATER TREATMENT AND REUSE

Specific actions identified for Wastewater Treatment and Reuse over the next 10-year period include actions in five categories as follows:

- 1) High Treatment Levels for Treated Wastewater
- 2) Address Septic Systems and Small Community Systems
- 3) Expand Water Reuse for Irrigation
- 4) Develop Water Reuse for Snowmaking
- 5) Investigate Shallow Groundwater Recharge

3.4.1 Action Items – High Treatment Levels for Treated Wastewater

To ensure that wastewater generated in the Big Sky area doesn't negatively impact the ecological health of the river systems, it will need to be treated to a high level and wastewater reuse will need to be carefully managed and monitored. Quick start activities include an analysis of treatment levels attainable with upgrades to the existing BSCWSD wastewater treatment plant, which will be conducted by the BSCWSD. Included in this analysis will be an assessment of both the necessary and desirable levels of treatment for water to be reused for irrigation compared to snowmaking compared to shallow groundwater recharge to ensure that there is no negative ecological impact to the river systems. In addition, community outreach will be conducted to educate the community on the various treatment levels attained at the BSCWSD, Yellowstone Club and Moonlight Basin treatment plants compared to individual septic systems and small community systems. In the short-term, engineering details and costing information for BSCWSD wastewater treatment plant upgrades will be developed. Identifying treatment levels necessary to provide ecological benefits for other potential reuse alternatives will also be evaluated. Extending from the short-term into the mid-to-long term, treatment plant upgrades will be instituted at the BSCWSD, Yellowstone Club and Moonlight Basin treatment plants as opportunities arise.

A summary of actions during the next 10 years for High Treatment Levels for Treated Wastewater include the following, which are also presented in **Table 3-10**:

Quick Start (2018)

- Identify potential treatment levels attainable with BSCWSD wastewater treatment plant upgrades
- Educate community on treatment levels for the various types of systems currently in use
- Identify necessary treatment levels for priority reuse alternatives (irrigation, snowmaking, shallow groundwater recharge)

Short-to-Long-term (2019-2029+)

- Upgrade treatment plant infrastructure to improve level of treatment
- Continue to educate community on treatment levels for the various types of systems currently in use
- Continue to identify necessary treatment levels for priority reuse alternatives (irrigation, snowmaking, shallow groundwater recharge); incorporate cost information as available
- Identify the potential for the use of treatment wetlands
- Upgrade treatment levels as opportunities arise across all infrastructure

Table 3-10. Implementation Action Items for High Treatment Levels for Treated Wastewater

High Treatment Levels for Treated Wastewater			
Quick Start (2018)	Short-term (2019-2023)	Mid-term (2024-2028)	Long-term (2029+)
Identify potential treatment levels attainable with BSCWSD wastewater treatment plant upgrades	Upgrade treatment plant infrastructure to improve level of treatment	Continue to upgrade treatment plant infrastructure to improve level of treatment	Continue to upgrade treatment plant infrastructure to improve level of treatment
Educate community on treatment levels for the various types of systems currently in use	Continue to educate community on treatment levels for the various types of systems currently in use	Continue to educate community on treatment levels for the various types of systems currently in use	Continue to educate community on treatment levels for the various types of systems currently in use
Identify necessary treatment levels for priority reuse alternatives (irrigation, snowmaking, shallow groundwater recharge)	Continue to identify necessary treatment levels for priority reuse alternatives (irrigation, snowmaking, shallow groundwater recharge); incorporate cost information as available		
	Identify the potential for the use of treatment wetlands		
	Upgrade treatment levels as opportunities arise across infrastructure	Continue to upgrade treatment levels as opportunities arise across infrastructure	Continue to upgrade treatment levels as opportunities arise across infrastructure

3.4.2 Action Items – Address Septic Systems and Small Community Systems

Septic systems and small community systems contribute significantly higher nutrient loads than advanced centralized treatment systems, but are often the best suited and most feasible wastewater treatment system for low-density development. Quick start actions include the convening of a group of community leaders and engaged citizens in the Gallatin Canyon to begin exploring options for the improved treatment of wastewater. This partnership will develop actions for the short-to-long terms to implement septic system and small community system upgrades, evaluate the potential to centralize treatment by expanding the BSCWSD or establishing a new district, and coordinate this strategy with Gallatin County so that septic system upgrades can be focused in areas that are unlikely to be incorporated into a centralized system. Another quick start action is to provide outreach and education to the community on septic maintenance, which will continue into the short-to-long term. To enhance scientific understanding of the Lower Basin (“Canyon”) aquifer, a MBMG GWIP study will be applied for. Additional groundwater and surface water monitoring will also be implemented to document groundwater and surface water interactions upstream and downstream of the West Fork Gallatin River confluence with the mainstem Gallatin River and to identify potential nutrient loading due to septic system inputs throughout the Gallatin Canyon. In the short-term, a plan will be developed to enhance BSCWSD’s ability to receive septage, with a long-term goal of eliminating the need to truck septage down to the Gallatin valley.

A summary of actions during the next 10 years for Addressing Septic Systems and Small Community System include the following, which are also presented in **Table 3-11**:

Quick Start (2018)

- Engage septic system and small community system owners in the Gallatin Canyon and outlying areas
- Education and outreach on septic maintenance
- Apply to MBMG for funding for Lower Basin (“Canyon”) aquifer study; including nutrient loading assessment
- Evaluate groundwater data in the Gallatin Canyon and surface water data for the Gallatin River; expand monitoring to document nutrient inputs from septic systems

Short-term (2019-2023)

- Continue to engage septic system and small community system owners in the Gallatin Canyon and outlying areas
- Continue education and outreach on septic maintenance
- Conduct Lower Basin (“Canyon”) aquifer study; including nutrient loading assessment
- Continue groundwater and surface water monitoring along the Gallatin River to document nutrient inputs from septic systems
- Develop and implement a plan with BSCWSD to accept more septage and reduce the need to truck to Gallatin Valley
- Implement septic system and small community system upgrades
- Coordinate with Gallatin County on areas for septic system upgrades compared to areas likely to be placed on a centralized system

Mid-to-Long-term (2024-2029+)

- Continue to engage septic system and small community system owners in the Gallatin Canyon and outlying areas
- Continue education and outreach on septic maintenance
- Continue groundwater and surface water monitoring along the Gallatin River to document nutrient inputs from septic systems
- Continue with septic system and small community system upgrades
- Implement strategy to improve septic systems in areas that are unlikely to be placed on a centralized system
- Develop and implement a strategy for centralizing a portion of the existing septic systems and small community systems, either by expanding existing BSCWSD boundaries or establishing a new district, if indicated as Lower Basin (“Canyon”) residential decision on most feasible strategy

Table 3-11. Implementation Action Items to Address Septic Systems and Small Community Systems

Address Septic Systems and Small Community Systems			
Quick Start (2018)	Short-term (2019-2023)	Mid-term (2024-2028)	Long-term (2029+)
Engage septic system and small community system owners in the Canyon and outlying areas	Continue to engage septic system and small community system owners in the Canyon and outlying areas	Continue to engage septic system and small community system owners in the Canyon and outlying areas	Continue to engage septic system and small community system owners in the Canyon and outlying areas
Education and outreach on septic maintenance	Continue education and outreach on septic maintenance	Continue education and outreach on septic maintenance	Continue education and outreach on septic maintenance
Apply to MBMG for funding for Lower Basin ("Canyon") aquifer study; including nutrient loading assessment	Conduct Lower Basin ("Canyon") aquifer study; including nutrient loading assessment		
Evaluate groundwater data in the Gallatin Canyon and surface water data for the Gallatin River; expand monitoring to document nutrient inputs from septic systems	Continue groundwater and surface water monitoring along the Gallatin River to document nutrient inputs from septic systems	Continue groundwater and surface water monitoring along the Gallatin River to document nutrient inputs from septic systems	Continue groundwater and surface water monitoring along the Gallatin River to document nutrient inputs from septic systems
	Develop and implement a plan with BSCWSD to accept more septage and reduce the need to truck to Gallatin Valley		
	Implement septic system and small community system upgrades	Continue with septic system and small community system upgrades	Continue with septic system and small community system upgrades

Address Septic Systems and Small Community Systems			
Quick Start (2018)	Short-term (2019-2023)	Mid-term (2024-2028)	Long-term (2029+)
	Coordinate with Gallatin County on areas for septic system upgrades compared to areas likely to be placed on a centralized system	Implement strategy to improve septic systems in areas that are unlikely to be placed on a centralized system	Continue to implement strategy to improve septic systems in areas that are unlikely to be placed on a centralized system
		Develop strategy for centralizing a portion of the existing septic systems and small community systems, either by expanding existing BSCWSD boundaries or establishing a new district, if indicated as Lower Basin (“Canyon”) residential decision on most feasible strategy	Implement strategy for centralizing a portion of the existing septic systems and small community systems, either by expanding existing BSCWSD boundaries or establishing a new district, if indicated as Lower Basin (“Canyon”) residential decision on most feasible strategy

3.4.3. Action Items – Expand Water Reuse for Irrigation

Irrigating on local golf courses and community parks with treated wastewater effluent is a long-established practice in the Big Sky area and action items include expanding irrigation reuse, modernizing irrigation management, and improving tracking and monitoring of irrigation water to ensure that the land applied wastewater is fully consumed by plant uptake and is not inadvertently seeping into the shallow groundwater system and flowing into adjacent streams. A quick start action is to establish a plan for additional irrigation monitoring to ensure full consumption of irrigation water. Identifying areas to expand irrigation into other open spaces and residential areas through the construction of a purple pipe network is a quick start action that will continue into the short-to-mid-term. In the short-term, additional monitoring will be implemented to track nutrient application and nutrient loading information will be used to inform the purchase and application of additional fertilizers by golf course managers. Actions taken to improve irrigation water management will be relayed to the community to communicate progress. In the short-to-mid-term, identifying the relationship between irrigation and groundwater recharge will inform future management decisions and the soon-to-be completed MBMG GWIP study of the Meadow Village aquifer will provide additional insights. In the short-term, mapping existing drain tiles under the Big Sky Golf Course will also inform management decisions regarding irrigation rates and timing and provide a basis for developing a plan in the mid-term to remove the drain tiles or eliminate their connectivity with the West Fork Gallatin River.

A summary of actions during the next 10 years for Expanding Water Reuse for Irrigation include the following, which are also presented in **Table 3-12**:

Quick Start (2018)

- Develop partnerships and coordinating mechanism for modernizing greenspace management with irrigation reuse
- Develop plan with BSCSWD for additional monitoring in irrigated areas to ensure full consumption of land applied effluent
- Start identifying areas for irrigation expansion using purple pipes

Short-term (2019-2023)

- Establish modernized greenspace management
- Implement monitoring of irrigated areas to ensure full consumption of land applied effluent; communicate progress to community
- Expand irrigation into new areas using purple pipes; continue identifying areas for additional irrigation expansion
- Develop plan for expanded storage and seasonal considerations for reuse between irrigation and snowmaking
- Map existing drain tiles under Big Sky Golf Course and develop a plan to address potential transport of land applied water to the river through the drain tiles
- Identify relationship between irrigation and groundwater recharge

Mid-to-Long-term (2024-2029+)

- Continue monitoring of irrigated areas to ensure full consumption of land applied effluent; communicate progress to community
- Continue to expand irrigation into new areas using purple pipes; continue identifying areas for additional irrigation expansion

- Implement plan for expanded storage and seasonal considerations for reuse between irrigation and snowmaking
- Implement a plan to address potential transport of land applied wastewater to the river through drain tiles on the Big Sky Golf Course

Table 3-12. Implementation Action Items to Expand Water Reuse for Irrigation

Expand Water Reuse for Irrigation			
Quick Start (2018)	Short-term (2019-2023)	Mid-term (2024-2028)	Long-term (2029+)
Develop partnerships and coordinating mechanism for modernizing greenspace management with irrigation reuse	Establish modernized greenspace management		
Develop plan with BSCSWD for additional monitoring in irrigated areas to ensure full consumption of land applied effluent	Implement monitoring of irrigated areas to ensure full consumption of land applied effluent; communicate progress to community	Continue monitoring of irrigated areas to ensure full consumption of land applied effluent; communicate progress to community	Continue monitoring of irrigated areas to ensure full consumption of land applied effluent; communicate progress to community
Start identifying areas for irrigation expansion using purple pipes	Expand irrigation into new areas using purple pipes; continue identifying areas for additional irrigation expansion	Continue to expand irrigation into new areas using purple pipes; continue identifying areas for additional irrigation expansion	Continue to expand irrigation into new areas using purple pipes; continue identifying areas for additional irrigation expansion
	Develop plan for expanded storage and seasonal considerations for reuse between irrigation and snowmaking	Implement plan for expanded storage and seasonal considerations for reuse between irrigation and snowmaking	Continue to implement plan for expanded storage and seasonal considerations for reuse between irrigation and snowmaking
	Map existing drain tiles under Big Sky Golf Course and develop a plan to address potential transport of land applied water to the river through the drain tiles	Implement a plan to address potential transport of land applied wastewater to the river through drain tiles on the Big Sky Golf Course	
	Identify relationship between irrigation and groundwater recharge		

3.4.4 Action Items – Develop Water Reuse for Snowmaking

Snowmaking with treated wastewater effluent provides for water storage and runoff patterns in sync with the natural hydrologic cycle, which provides high streamflows during spring runoff necessary for maintaining dynamic instream habitat and provides aquifer recharge that supports late-season streamflows. Snowmaking with treated wastewater effluent is currently conducted at several ski resorts in North America and a pilot project has been conducted by the Yellowstone Club in partnership with BSCWSD and DEQ. Quick start actions for establishing snowmaking in the Big Sky area by 2020 include establishing a regulatory framework with DEQ and determining required monitoring parameters for permitting. Reaching out to other ski areas in North America that have successfully implemented this type of program is another quick start action. In the short-term, identifying the required treatment level of snowmaking and performing the necessary improvements at the BSCWSD will be necessary. Since snowmaking will rely heavily on the storage of treated effluent, identifying additional storage needs is a quick start action. In the short-term, constructing the necessary infrastructure improvements, including pipes, storage ponds and snowmaking equipment, will be completed by project partners, including BSCWSD, Yellowstone Club, Spanish Peaks and Big Sky Resort. As snowmaking with treated effluent comes online in 2020, water quality monitoring will be conducted under the Watershed Status and Trends Program to ensure there is no negative ecological impact to the river systems. Moving into the mid-to-long term, additional areas for expansion will be identified and the necessary infrastructure will be developed to potentially reuse 300 MG of treated effluent at Big Sky Resort and 30-40 MG on Eglise Ridge at the Yellowstone Club.

A summary of actions during the next 10 years for Developing Water Reuse for Snowmaking include the following, which are also presented in **Table 3-13**:

Quick Start (2018)

- Initiate process with DEQ to develop a regulatory framework for making snow with treated effluent
- Determine monitoring parameters required for permitting snowmaking with treated effluent and develop monitoring network and SAP; begin monitoring
- Examine other areas where treated effluent is being used for snowmaking to help identify engineering and regulatory requirements
- Identify necessary infrastructure improvements (pipes, ponds, etc.) required to begin snowmaking with treated effluent by November of 2020

Short-term (2019-2023)

- Finalize regulatory framework; obtain approval from the Board of Environmental Review
- Develop effective coordinating mechanism between BSCWSD and ski resorts
- Continue monitoring network aimed at permitting snowmaking with treated effluent and tracking water quality during implementation
- Construct necessary infrastructure improvements (pipes, ponds, etc.) required to begin snowmaking with treated effluent by November of 2020; expand acreage through additional infrastructure
- Identify necessary treatment levels to ensure no negative environmental impacts
- Develop plan for expanded storage and seasonal considerations for reuse between irrigation and snowmaking

Mid-to-Long-term (2024-2029+)

- Continue monitoring network to track water quality during implementation
- Expand snowmaking and infrastructure
- Implement plan for expanded storage and seasonal considerations for reuse between irrigation and snowmaking

Table 3-13. Implementation Action Items to Develop Water Reuse for Snowmaking

Develop Water Reuse for Snowmaking			
Quick Start (2018)	Short-term (2019-2023)	Mid-term (2024-2028)	Long-term (2029+)
Initiate process with DEQ to develop a regulatory framework for making snow with treated effluent	Finalize regulatory framework; obtain approval from the Board of Environmental Review		
Determine monitoring parameters required for permitting snowmaking with treated effluent and develop monitoring network and SAP; begin monitoring	Continue monitoring network aimed at permitting snowmaking with treated effluent and tracking water quality during implementation	Continue monitoring network to track water quality during implementation	Continue monitoring network to track water quality during implementation
Develop effective coordinating mechanism between BSCWSD and ski resorts			
Examine other areas where treated effluent is being used for snowmaking to help identify engineering and regulatory requirements			
Identify necessary infrastructure improvements (pipes, ponds, etc.) required to begin snowmaking with treated effluent by November of 2020	Construct necessary infrastructure improvements (pipes, ponds, etc.) required to begin snowmaking with treated effluent by November of 2020; expand acreage through additional infrastructure	Expand snowmaking and infrastructure	Expand snowmaking and infrastructure
	Identify necessary treatment levels to ensure no negative environmental impacts		

Develop Water Reuse for Snowmaking			
Quick Start (2018)	Short-term (2019-2023)	Mid-term (2024-2028)	Long-term (2029+)
	Develop plan for expanded storage and seasonal considerations for reuse between irrigation and snowmaking	Implement plan for expanded storage and seasonal considerations for reuse between irrigation and snowmaking	Continue to implement plan for expanded storage and seasonal considerations for reuse between irrigation and snowmaking

3.4.5 Action Items – Investigate Shallow Groundwater Recharge

Shallow groundwater recharge uses treated effluent or stormwater and directly injects it, typically without further soil percolation, to augment an existing groundwater resource. This can be accomplished through several types of subsurface injection methods. For the Meadow Village aquifer, MBMG is currently wrapping up its GWIP study and quick start actions include reviewing the results of the study, instituting protective measures based on the results, developing a plan to continue monitoring at sites established by MBMG, and identifying additional sites for groundwater monitoring. Applying for a MBMG GWIP study of the Lower Basin (“Canyon”) aquifer is a quick start action and, if awarded, the project could be completed in the short-term. Examining the regulatory process for shallow groundwater recharge to evaluate the potential for irrigation with treated wastewater effluent to provide for shallow groundwater recharge without negatively impacting the ecological health of the river systems is a quick start to short-term action.

A summary of actions during the next 10 years to Investigate Shallow Groundwater Recharge include the following, which are also presented in **Table 3-14**:

Quick Start (2018)

- Review results of MBMG Meadow Village aquifer study and identify opportunities for recharging the Meadow Village aquifer
- Apply to MBMG for funding for Lower Basin (“Canyon) aquifer study; include characterization of aquifer recharge capacity
- Identify groundwater monitoring sites
- Examine regulatory process

Short-term (2019-2023)

- Conduct Lower Basin (“Canyon) aquifer study
- Implement additional groundwater monitoring
- Assess "fully consumptive" irrigation requirements and potentially modify to "maximize consumption as necessary"

Mid-to-Long-term (2024-2029+)

- Identify areas for future study
- Implement shallow groundwater recharge project if potential exists

Table 3-14. Implementation Action Items to Investigate Shallow Groundwater Recharge

Investigate Shallow Groundwater Recharge			
Quick Start (2018)	Short-term (2019-2023)	Mid-term (2024-2028)	Long-term (2029+)
Review results of MBMG Meadow Village aquifer study and identify opportunities for recharging the Meadow aquifer			
Apply to MBMG for funding for Lower Basin ("Canyon") aquifer study; include characterization of aquifer recharge capacity	Conduct Lower Basin ("Canyon") aquifer study		
Identify groundwater monitoring sites	Implement additional groundwater monitoring		
Examine regulatory process			
	Assess "fully consumptive" irrigation requirements and potentially modify to "maximize consumption as necessary"		
		Identify areas for future study	
		Implement shallow groundwater recharge project if potential exists	

3.5 ACTION ITEMS FOR AREAS OF SUSTAINING FUNDING AND COMMUNITY ENGAGEMENT

3.5.1 Action Items – Sustaining Funding

Recommendations and actions in each of the three water resources focus areas will require increased capacity and long-term sustained funding, which will come from three primary sources:

- **Operational budgets:** Funding in existing organizational budgets which can be further directed or redirected to the actions in this plan.
- **Existing grant sources:** Several projects and actions lend themselves to existing grant sources from local, state, federal and private sources. Individual partners will pursue grants that are best suited to specific projects and short-term capacity needs.
- **Long-term sustainable funds:** New funding sources will be necessary to meet long-term funding needs and the increased capacity identified in this watershed stewardship plan.

The actions identified in this watershed stewardship plan will require all three sources of funding. However, establishing a new long-term funding source will likely be the most difficult set of actions and action items focus primarily on creating this funding mechanism.

Quick Start (2018)

- Establish a funding committee and coordinator; identify funding sources
- Develop fundraising plan
- Explore funding to support currently unpaid expertise for specific implementation actions
- Explore Water Fund mechanisms and determine the most feasible approaches

Short-term (2019-2023)

- Continue with funding committee and coordinator
- Implement fundraising plan
- Establish community Water Fund or alternate measure of long-term sustainable funding
- Share progress and promote community payment for water resources services
- Explore tax and bond options as opportunities arise

Mid-to-Long-term (2024-2029+)

- Continue with funding committee and coordinator
- Continue to implement fundraising plan
- Continue Water Fund or alternate measure of long-term sustainable funding
- Continue to share progress and promote community payment for water resources service
- Explore tax and bond options as opportunities arise

Table 3-15. Implementation Action Items for Sustaining Funding

Sustaining Funding			
Quick Start (2018)	Short-term (2019-2023)	Mid-term (2024-2028)	Long-term (2029+)
Establish a funding committee and coordinator; identify funding sources	Continue with funding committee and coordinator	Continue with funding committee and coordinator	Continue with funding committee and coordinator
Develop fundraising plan	Implement fundraising plan	Continue implementing fundraising plan	Continue implementing fundraising plan
Explore funding to support currently unpaid expertise for specific implementation actions			
Explore Water Fund mechanisms and determine most feasible approaches	Establish community Water Fund or alternate measure of long-term sustainable funding	Continue Water Fund or alternate measure of long-term sustainable funding	Continue Water Fund or alternate Measure of long-term sustainable funding
	Share progress and promote community payment for water resources services	Continue to share progress and promote community payment for water resources services	Continue to share progress and promote community payment for water resources services
	Explore tax and bond options, as opportunities arise	Explore tax and bond options, as opportunities arise	Explore tax and bond options, as opportunities arise

3.5.2 Action Items – Community Engagement

Ongoing community engagement will be necessary for the successful implementation of this watershed stewardship plan. To engage and educate the Big Sky area community about the three water resources focus areas and the value of clean water, a series of infographics were developed and are presented in **Appendix J**. Community engagement quick start actions include developing a “Trout Friendly” certification program, establishing a conservation award, and using the infographics to share the message with the community. Community engagement activities will continue through the long-term.

Quick Start (2018)

- Develop community engagement plan
- Develop a “Trout Friendly” certification program
- Establish a conservation award
- Use infographics to share message of plan and benefits to the community

Short-term (2019-2023)

- Continue community engagement work; evaluate community awareness
- Implement “Trout Friendly” certification program
- Implement conservation award

Mid-to-Long-term (2024-2029+)

- Continue community engagement work; evaluate community awareness
- Continue “Trout Friendly” certification program
- Continue conservation award

Table 3-16. Implementation Action Items for Community Engagement

Community Engagement			
Quick Start (2018)	Short-term (2019-2023)	Mid-term (2024-2028)	Long-term (2029+)
Develop community engagement plan	Continue community engagement work; evaluate community awareness	Continue community engagement work; evaluate community awareness	Continue community engagement work; evaluate community awareness
Develop a "Trout Friendly" certification program	Implement "Trout Friendly" certification program	Continue "Trout Friendly" certification program	Continue "Trout Friendly" certification program
Establish a conservation award	Implement conservation award	Continue conservation award	Continue conservation award
Use infographics to share message of plan and benefits with community			

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APPENDICES

Appendix A

Big Sky Sustainable Water Solutions Stakeholder Assessment Summary April 2016



Big Sky Sustainable Water Solutions Stakeholder Assessment Summary

April 2016

Healthy watersheds and clean and abundant water resources are a vital part of the Big Sky area, now and into the future. The Big Sky area, roughly delineated by the resort tax boundaries and an associated zone of influence that includes the Madison and Gallatin watersheds, is dependent on clean water and healthy natural systems.

Development has once again taken off in Big Sky. Yet much of the greater Big Sky area is yet to be developed. A question many have expressed is how Big Sky can grow and develop economically, keeping in mind potential limits to water supply, availability and ability to treat and dispose wastewater. At the same time, sustaining the health of the Gallatin and Madison, their tributaries and overall watersheds is also important.

The Gallatin River Task Force (GRTF) agreed to act as host and leader for a community-based collaboration, focused around addressing water resources, if sufficient interest and common ground was identified. Funding for this initial stage was provided by the Lone Mountain Land Company and Yellowstone Club.

Stakeholder Selection

In January 2016, the Gallatin River Task Force initiated an effort to gauge public interest in convening a community-based, collaborative watershed planning process in the Upper Gallatin Watershed. The impetus for exploring this idea came from the general absence of a forum for sharing information among interest groups and identifying opportunities to work together towards common watershed goals. In March and April 2016, 33 stakeholders were interviewed, representing community, business, conservation, agency and local government interests. (See the appendix for list of entities.) Interviewees were polled as to their water resource concerns and interest in conducting a community-based, collaborative process. Stakeholders were selected to cover as many perspectives as possible. For this analysis, stakeholders were grouped as:

- Community Members and Business Interests
- Local Government and Agency Representatives
- Non-profit Interests

Definitions of the Big Sky Area

Big Sky is not an incorporated entity, so defining the geographical area of interest is important. Almost all stakeholders included the following areas:

- Developed area of the mountain, including private clubs (Big Sky Resort, Yellowstone Club, Spanish Peaks, Moonlight)
- Meadow area and private land on the surrounding upland areas

- Gallatin Canyon, though the exact boundaries varied from just at the mouth of the West Fork and turn-off to the entire canyon
- Parts of both Madison and Gallatin counties
- Parts of both Madison and Gallatin watersheds

Additionally, Jack Creek was included by the majority of stakeholders though many pointed out that it is much less developed. Many also included the public lands that make up the headwaters of the North Fork, West Fork and South Fork above the developed area of Big Sky and several included public lands that lay within the canyon area as each stakeholder defined it. The **resort tax boundary** was frequently identified as a reasonable way to define the core Big Sky area.

In addition, several stakeholders identified a larger geographic area that is a **zone of influence** that includes an area that is impacted or has the potential to impact the core Big Sky area. This area includes the Gallatin and Madison watersheds and population in the valley areas of those watersheds.

Several stakeholders offered criteria for their definitions. These **criteria** were:

- **Developed Area of Big Sky:** (both platted and built) in the immediate Big Sky core.
- **Economic Impact:** Two major types of definitions were offered. The smaller geographic boundary was defined by those who live in the immediate developed area of Big Sky or regularly shop and do business in Big Sky. The larger economic zone extended to include commuters and communities including Bozeman, Belgrade, Four Corners, Gallatin Gateway and Ennis.
- **Recreation Zone:** Recreational opportunities associated with the Big Sky area were identified both within the core Big Sky area and in a broader area of the canyon and mountains on both sides of the Gallatin.
- **Ecological and Natural Boundaries:** The animal or plant community named affected the boundary, but all were considerably larger than the developed area. For hydrology, the boundary was based on watersheds for surface water and aquifers for ground water.
- **School District Boundary:** These boundaries define a community that focused on Big Sky.

Major Commonalities and Focus Areas

Stakeholders expressed strong interest in a community-based effort. The **goal** of the collaboration is to identify sustainable solutions for water supply and wastewater treatment in the Big Sky area, while ensuring the ecological integrity of the headwaters river system. Participants identified three focus areas:

- Clean water supply and availability
- Wastewater treatment and disposal
- Sustaining the ecological health of the river systems

Water Resource and Other Areas of Concern

Each stakeholder was asked to identify priority water resources concerns or questions. Stakeholders identified a wide range of concerns, as well as questions or requests for more information.

Areas of Concern as Identified by Stakeholders			
Areas of Concern	Community Members and Business Interests (11 interviews)	Local Government and Agency Representatives (9 interviews)	Non-profit Interests (10 interviews)
Water Supply and Availability	9	7	8
Wastewater Treatment and Disposal	11	9	10
Sustaining the Ecological Health of the River Systems	10	8	10
Other Concerns	8	8	9

Overall, participants had strong interest in all three major water resource focus areas. They also mentioned other areas that are impacted by water resources or impact them. Within each category, participants identified many sub-categories that merited further questions or concerns. Some, like effluent disposal, were mentioned by most participants; other issues, like water mitigation, were only mentioned by a few.

Water Supply and Availability: The physical supply of drinking and irrigation water is complex, so supply of high quality water is not a concern in some areas and a significant concern in others. Mitigation, downstream impacts, and exempt wells were also mentioned. Several informational gaps and questions also were raised in this area.

Wastewater Treatment and Disposal: This was the area that all participants listed at least one concern or question. Effluent treatment and disposal, now and in the future, came up very frequently. Existing and potential impacts to the river systems, septic and other non-Big Sky Water and Sewer District (BSWSD) treatment options, and capacity limits and its impact on development also were brought up frequently. Respondents appeared most knowledgeable about impacts and alternatives in this focus area.

Sustaining the Ecological Health of the River Systems: Current and potential water quality impacts to rivers, streams and wetlands were frequently listed concerns. Past, current and potential impacts to surface water quality were identified, both in the Big Sky area and downstream. Changes to in-stream flows, riparian habitat, and wetlands were listed as concerns. Ground water/surface water connections, as well as landscape connectivity were also frequently listed as important. Fisheries, wildlife, recreational opportunities and impacts, cumulative impacts, and scenic values were also identified by several participants. Overall, the level of knowledge was quite varied in this category. Several stakeholders had questions about current and potential impacts.

Other Concerns: Several participants identified economic and development concerns including rate of growth, traffic, public transportation, emergency services, and affordable housing. Ability to provide effective oversight, accountability and gaps or difficulties with regulations were concerns mentioned several times. Other concerns included climate change, drought, fire, and potential impacts to human health.

Collaborative Process

Level of Interest and Collaborative Role

Each stakeholder was asked to identify his or her interest in a collaborative process. Every stakeholder did identify an interest in a community-based collaborative process.

Participants were also asked about their potential level of involvement in such a collaborative process. Level of interest in involvement varied from communication and information sharing to extensive, long-term involvement.

Some participants with limited time or a specific expertise in a water resource area or community issue did say they would like to have access to ongoing information, but would like to be active only when specific topics were discussed. Some others interested in broader resource and community issues said that they would not be sure of their level of involvement until the goals were more specifically defined.

Initial Input on Structure and Approach of a Community-Based Collaborative Process

The majority of interviewed stakeholders had experience with collaborative processes. Many of those stakeholders offered observations and suggestions that would help create a successful collaborative process. Because past experiences and topics had varied so significantly, not all examples will mesh successfully. However, a few approaches were mentioned by several stakeholders. These included:

Actively Include Diverse Perspectives: Several stakeholders mentioned examples that did not work because the list of stakeholders involved was too narrow or identified successes because truly diverse stakeholders were included as equal partners.

Keep the Community Informed and the Process Transparent: Strong, ongoing communication with community members and publically available information was widely mentioned as important. The importance of transparency in a collaborative process was frequently mentioned. However, a few stakeholders did note that this approach may slow down the process because more people will want to weigh in and conflict may increase during the process.

Clear Goals and Purpose: Several stakeholders identified clear goals and objectives, both short term and long term, as important for success.

A Process that Supports Analysis and Decision-making: A variety of structures were mentioned that resulted in successful collaboration, but common threads were: a clear structure, framework and set of ground rules; ongoing support to ensure that meetings were held regularly and the availability of clear information used to support participant ability to make decisions.

Opportunities, Tools, Challenges and Barriers

Stakeholders were asked to identify any opportunities, tools, challenges or barriers that might help or make it more difficult to address the water resource concerns each participant identified. The list presented has not been analyzed for feasibility. This input should be treated as initial thoughts that point the way to more sustained discussion, analysis, and decision-making in a collaborative process.

Opportunities and Tools

Stakeholders were asked to identify tools and opportunities that might be used to address the water resource concerns each stakeholder identified. At least 100 distinct opportunities and tools were identified. Major categories included:

Technical Tools: Several technical tools and approaches were identified. These included:

- **Wastewater Treatment and Disposal Options:** Include snow-making with effluent, further or different options for effluent irrigation and application, infiltration galleries, sewer extensions, treatment wetlands, and direct discharge.
- **Water Supply and Availability Options:** Water conservation options, community drought resiliency plan, other water planning models, pricing incentives for water use, and building wetlands for mitigation.
- **Sustaining Natural Systems:** This includes riparian restoration projects, changes in road maintenance, evaluation of the road system and extensions, wetlands restoration and enhancement, and forest management and restoration.
- **Enhancing Knowledge:** Additional surface water monitoring, wetland monitoring, further ground water monitoring, and further analysis of existing monitoring were all identified as helpful. Synthesis of existing technical studies and potential further investigations were also identified.

Community Tools and Opportunities: The Big Sky community has many assets and models that could be helpful in addressing water resources and could also capitalize on ideas other communities have used. Opportunities and tools included:

- **Collaboration Process:** Several stakeholders thought having a collaborative process would be helpful in addressing water resources and offered an opportunity. Several other collaborative processes were also identified as potential models for Big Sky.
- **Other Community Models:** Big Sky is not the only community facing water resources challenges. Several models were offered for consideration, and others suggested that further research and analysis would be helpful.
- **Education and Outreach Opportunities:** Several stakeholders already conduct education and outreach efforts in the Big Sky area and thought more could be done. Other opportunities might include involving the school.
- **Management and Policies:** Several types of plans and policies were identified as potentially useful including a watershed stewardship plan, growth management policies, recreation management, and road sanding management.
- **Economic Opportunities and Tools:** Economically, the area is booming, so the resort tax revenue is higher. A TED district is being investigated and may provide more funding capacity. Because

some segments of the community have significant wealth, there is the potential for focused funding to effectively address issues. Several grant opportunities were also identified that may apply to projects. Conservation easements are being used and could also be used further to protect high priority areas.

- **Common Values:** Many stakeholders identified common interests and values that have brought them to Big Sky and thought that the love of place, interest in keeping natural amenities of Big Sky, and a strong core of committed community members were seen as assets.

Planning, Policy and Regulatory Tools and Opportunities: Many saw opportunity in plans, policies and regulations.

- **Planning and Policy Opportunities:** The DNRC State Water Plan, a proactive TMDL for the Gallatin river, potential expansion of the controlled ground water area, and further use of the expanded Gallatin Local Water Quality District were all identified as opportunities. Working with the Legislature to change regulations that are barriers to innovative water resources solutions was also mentioned.
- **Regulatory Opportunities:** Several regulatory and permitting processes were identified as potentially useful including review during wastewater permit renewal, EPA's residual authority for stormwater, DEQ permitting, DNRC water rights change processes, and any future platting decisions.

Challenges and Barriers

Stakeholders were asked to identify any challenges or barriers that may create difficulties to addressing resource concerns. At least 60 distinct challenges or barriers were identified. However, most fell into a few major categories. These were:

Fragmented Decision-making and Multiple Jurisdictional Boundaries: This was the most frequently identified barrier to making effective decision-making. The core area is split by two counties, has both public and private land, a controlled ground water area, a number of different Home Owners Associations (HOAs), private clubs and a variety of businesses and developers. The Big Sky area is not incorporated, so no one governmental entity exists. Associated challenges several stakeholders identified included lack of oversight and regulations, limited ability to implement decisions, and self-interests that may make it difficult to compromise or come to agreements on solutions to address water resources.

Limited Existing Capacity to Treat and Store Wastewater: The Big Sky Water and Sewer District (BSWSD) capacity and limited service area was frequently identified. Associated issues included disposal solutions for treated effluent, especially as more development occurs, and costs associated with extending sewer services.

Legal and Physical Water Supply: Several stakeholders had questions about the supply and legal availability of water, particularly in areas that aren't served by the BSWSD and that get water from the shale aquifers.

Complex and Fragile Natural Systems: The Big Sky area encompasses the headwaters of two watersheds. Additionally, several identified complex geology and differing aquifer types, and difficulties associated with development in a sub-alpine environment with significant wildlife resources.

Limited Physical Area Available for Development: The Big Sky area is finite and build-out is thought to be capped. The water supply and wastewater treatment and disposal capacity are both perceived as limited too. Associated with this were economic challenges like higher cost of living and difficulty in siting affordable housing in Big Sky.

Pace of Development: Development is quite rapid again, after a few slow years during the recession. This means that the window of opportunity for decision-making may be brief.

Role of Wealth and Part-time Residents in the Community: Differing concerns about wealth identified challenges. A few mentioned that the perception that there is so much wealth in Big Sky that no outside resources are needed. Conversely, a few others thought that wealthy landowners and developers had the potential for disproportionate influence on community decision-making. Some participants mentioned difficulties in informing and engaging part-time residents.

Next Steps

Based on the input from the stakeholders interviewed, the Gallatin River Task Force (GRTF) and other community leaders have now made a decision to move forward with this watershed planning initiative. Between now and the end of 2017, it is expected that GRTF will host a community-based forum. It will:

- Form and support a community-based stakeholder group to address water resource concerns.
- Develop a common understanding of water supplies and availability, water quality, restoration and preservation of the watershed, and wastewater treatment and disposal.
- Identify and evaluate options for future water supply, wastewater treatment and disposal, and preservation and restoration of natural river systems within the Big Sky area, using objective criteria.

The **final product** is expected to be a **watershed management plan** to sustain and enhance drinking water and wastewater infrastructure and support and improve healthy, properly functioning watersheds.

Appendix: Initial Assessment Stakeholder List

The Gallatin River Task Force (GRTF) conducted an initial assessment of stakeholder interest and the identification of focus areas for a collaborative process focused on water resources. A total of 33 stakeholders took part in 30 interviews. In addition to the entities represented below, several stakeholders also were affiliated with other boards, organizations and businesses. The stakeholders were chosen to represent as broad of set of knowledgeable perspectives as possible. The primary entities represented were:

Community Members and Business Interests

Alpine Water
Big Sky Chamber of Commerce
Big Sky Owners Association
Big Sky Resort
Big Sky Town Center
Big Sky Vacation Rentals
Buck's T-4
Geyser Whitewater
Lone Mountain Land Company
Yellowstone Club
Big Sky Trout
Big Sky Resort Tax Area District Board

Local Government and Agency Representatives

Big Sky County Water and Sewer District
Gallatin County Commissioner
Gallatin Local Water Quality District
Madison Conservation District
Madison County Commissioner
Montana Bureau of Mines and Geology
Montana Department of Environmental Quality
Montana Department of Natural Resources
Custer-Gallatin National Forest

Non-profit Interests

American Rivers
Association of Gallatin Agricultural Irrigators
Big Sky Community Corporation
Future West
Gallatin River Task Force
Greater Gallatin Watershed Council
Greater Yellowstone Coalition
Montana Land Reliance
Trout Unlimited
Upper Missouri Waterkeeper

Appendix B

Stakeholder Meeting Presentation Summaries: Ecological Health of River Systems August 2016

Presentations: Ecological Health of River Systems August 31, 2016 Stakeholder Meeting

Overview of Ecological Health of River Systems, Jeff Dunn, Watershed Hydrologist, RESPEC

Jeff Dunn provided an overview of the Big Sky community and river system. He highlighted the project area, delineated as the resort tax boundaries, and the larger zone of influence of the Gallatin and Madison watersheds. First, he summarized information and projections of population, build-out and visitation. Population projections based on US Census data, range from 4,500-14,000 by 2040 for the Big Sky area. A 2011 estimate stated that full build-out is about 7,400 residential units, with a peak residential population of 16,000. A 2013 community profile found that 15,000+ visitors/day are present during peak times of the year. Visitation is highest in the winter, though summer-time visitation has been rising. Hydrologic boundaries of the project area include the headwaters of both the Gallatin and Madison River watersheds. The project area includes the mainstem of the Gallatin River, which flows north through the project area, extending from Red Cliff Campground downstream to Karst. Subwatersheds include Porcupine Creek, Portal Creek, Moose Creek, Beaver Creek, and Deer Creek, along with streams in the West Fork Gallatin River watershed. Jack Creek is the major drainage to the Madison River within the project area, though portions of the Cedar Creek and Indian Creek subwatersheds are also within the project area.

The West Fork Gallatin River watershed includes the Middle Fork West Fork Gallatin River, North Fork West Fork Gallatin River, South Fork West Fork Gallatin River, and West Fork Gallatin River. The Middle Fork West Fork Gallatin River watershed includes Beehive Creek, along with un-named tributaries that are locally referred to as "Moose Tracks" Creek and "Stony" Creek. The Middle Fork West Fork Gallatin River headwaters on Lone Mountain and flows through Lake Levinsky, which is a man-made impoundment that impacts sediment transport through the system and acts as sediment trap. The North Fork West Fork Gallatin River is a steep large substrate mountain stream flowing primarily through National Forest lands. The South Fork West Fork Gallatin River headwaters between Lone Mountain and Pioneer Mountain and is a high energy mountain stream with high sediment transport capacity, high bedload transport, and naturally erosive geologies in the canyon section. Algae growth is observed in the lower reaches of the South Fork West Fork Gallatin River during summer low flow conditions. Tributaries to the South Fork West Fork Gallatin River include Muddy Creek, Third Yellow Mule Creek, Second Yellow Mule Creek, and First Yellow Mule Creek. The West Fork Gallatin River begins at the confluence of the Middle Fork West Fork Gallatin River and North Fork West Fork Gallatin River. The West Fork Gallatin River is referred to locally as the "upper" West Fork upstream of the confluence with the South Fork West Fork Gallatin River and the "lower" West Fork downstream of the confluence with the South Fork West Fork Gallatin River. The "upper" West Fork Gallatin River flows through the Big Sky Golf Course and flows through two man-made impoundments constructed during the early 1970's: Silverbow Pond and Little Coyote Pond. The construction of the Big Sky Golf Course in the early 1970's resulted in a loss of riparian habitat, loss of channel length, reduced channel sinuosity, increased channel slope, and reduced floodplain connectivity, which has led to accelerated streambank erosion and a loss of instream habitat complexity along the West Fork Gallatin River. In addition, algae growth is observed in the West Fork Gallatin River during summer low-flow conditions.

Water Quality Standards, Eric Urban, Bureau Chief, Water Quality Planning Bureau, Montana Department of Environmental Quality

Eric Urban discussed Montana's water quality standards. Water quality standards set the end goals for water quality to obtain in order to protect a use (such as aquatic life, recreation, etc.). The standards are designed to inform permitted and non-permitted sources of pollutants. The permits are then built to meet

water quality standards. Permits are required for point sources of pollution. This includes activities such as industrial application, publicly owned entities, Confined Animal Feeding Operations, storm water and others. No permits are required for non-point sources of pollution, including agriculture, forestry, septic systems and many other activities but they are still asked to comply with the same standards. Water quality standards include beneficial uses (different from water rights), criteria, and anti-degradation. Beneficial uses include Federal Clean Water Act uses of fishable and swimmable, along with State designated uses, including drinking water, agriculture, and wildlife. Criteria are a “number” developed to protect the beneficial uses, including narrative “free from” criteria and DEQ 7 and DEQ 12A (specific to nutrients), which are regulations with numbers. DEQ 12A defines the numeric Nutrient Criteria for Montana including streams/ivers near Big Sky to maintain the aesthetics for recreation and are intended to keep algae growth to a level that is acceptable to the public (below 30µg/L Total Phosphorus and 300 µg/L Total Nitrogen). For sediment, there are narrative criteria, which refer to maintaining conditions necessary to support the use, in this case likely the trout fishery. The TMDL presents details on sources of nutrients and sediment and how much each source contributes. Anti-degradation is a requirement that protects water for water’s sake, with three levels or “tiers” for keeping water clean, including Tier 1 – existing, Tier 2 – high quality, and Tier 3 – Outstanding Resource Water. Finally, when thinking about streams in the Big Sky area, Urban noted it is important to keep in mind the streams that are not listed as impaired. Monitoring is extensive along impaired streams where improvements are necessary, but there is a relative absence of information on other streams. The existing TMDLs are useful for implementing actions to reduce existing sources of pollution and minimize new sources of pollution.

Upper Gallatin River Watershed Trends in Water Quality, Kristin Gardner, Executive Director, Gallatin River Task Force

Kristin Gardner discussed water quality trends in the Upper Gallatin River Watershed. The Gallatin River Task Force (Task Force) has had a water quality monitoring program since 2000 and was the local liaison for Upper Gallatin River Watershed Total Maximum Daily Load (TMDL) assessment conducted between 2005 and 2010. Over time, additional monitoring sites have been added and monitoring includes both water quality and streamflows. Water quality monitoring throughout the seasons provides insight into the sources of pollutants and captures conditions during varying streamflows and varying levels of biological activity. During the winter, streamflow is lowest and there is limited biological uptake. Prior to snowmelt, flows start to increase, but biological uptake remains low. During spring runoff, streamflows are high and so is biological uptake. During the summers, streamflows decrease, while biological uptake is high. Monitoring parameters include temperature, pH, dissolved oxygen, nitrate, total nitrogen, total phosphorous, *E. Coli*, total coliform, conductivity, turbidity, chloride, and total dissolved solids, along with sediment size distribution, aquatic insects, algae, and streamflow. Four monitoring stations include collection of continuous data on temperature, conductivity, and water level.

Ongoing water quality monitoring conducted by the Task Force has identified the following spatial trends: nitrogen and chloride are elevated in the Middle Fork West Fork Gallatin River and West Fork Gallatin River, while algae growth is elevated in the Middle Fork West Fork Gallatin River, South Fork West Fork Gallatin River, and West Fork Gallatin River. Seasonal trends identified by the Task Force indicate that chloride is highest pre-snowmelt (March/April), turbidity is highest at runoff, nitrate is highest in the winter, and *E. coli* is highest in the summer. There are nutrient and sediment TMDLs for the Middle Fork West Fork Gallatin River, South Fork West Fork Gallatin River, and West Fork Gallatin River, and an *E. coli* TMDL for the Middle Fork West Fork Gallatin River. A 2009 study of the West Fork Gallatin River as it flows through the Big Sky Golf Course identified increased levels of nitrate and chloride, which are indicative of a wastewater source. In 2016, monitoring was conducted on the South Fork West Fork Gallatin River to assess potential impacts of the wastewater storage pond failure at the Yellowstone Club.

This assessment found that no human health standards were exceeded, but two aquatic life standards were exceeded: 1) acute ammonia standards on Second Yellow Mule Creek and the South Fork Gallatin River at sites closest to the spill; and 2) turbidity at all sites downstream of the spill during the timeframe that the pond was discharging effluent, primarily due to hillslope erosion as water flowed out of the storage pond and down the hillside.

Research conducted in partnership with Montana State University indicates that geology within the watershed has an influence on the spatial availability of nitrogen in the West Fork Gallatin River watershed. Algae growth is controlled by both nitrogen and phosphorus. There is variability in nitrogen concentrations and sources throughout the year, with higher concentrations in the winter and lower concentrations in the summer on the West Fork Gallatin River, while high nitrogen concentrations are observed year-round in the Mountain Village area. During the summer growing season, biological uptake by algae masks nitrogen concentrations. Recent research conducted by Montana State University indicates there is a significant diurnal fluctuation of total nitrogen, with concentrations lowest during the day when algae are photosynthesizing and using nitrogen.

Wetland and Land Conservation, Jessie Wiese, Southwest Manager, Montana Land Reliance

Jessie Wiese presented an overview on wetlands in the Big Sky area. Wetlands and riparian areas are considered the most important ecological component of the Montana environment from a landscape connectivity perspective. Nationwide, 50% of wetlands have been lost and approximately 60,000 acres of wetlands are still lost each year. Montana has lost roughly 30% of its wetlands. Wetlands perform functions including storing floodwater, filtration and providing habitat for many species. An acre of wetland can store 1-1.5 million gallons of floodwater. Fisheries are heavily dependent on wetlands and the Big Sky area economy is heavily dependent on fishing. Impacts to wetlands can lead to a decline in wildlife populations, increased flood damage, increased sedimentation to lakes and streams, contaminated drinking water and irrigation wells, reduced fish productivity due to poor water quality and habitat loss, reduced recreation opportunities and a loss of tourist dollars. Since 70% of U.S. is private land, most wetland conservation and restoration efforts are undertaken by private landowners. Common wetland types in the Big Sky are the fen, wet meadow, spring, and inter-montane pothole. The National Wetland Inventory provides wetland mapping using remote sensing techniques. Many wetlands have been mapped on-the-ground in Big Sky, generally in areas that are being developed, though this information is not readily available. 310 permits are needed when streambank and stream projects are undertaken, and 404 permits are required when dredging or filling in US waters occurs. Riparian areas and river corridors are priorities for conservation and conservation easements are a useful tool for conserving wetland and riparian areas. The Montana Land Reliance (MLR) prioritizes these areas and sees the Big Sky area as part of a larger landscape and connects projects whenever possible. Connectivity includes both structural and functional components, with structural components considering how close two habitat patches are and functional components considering how effective the patches are at helping wildlife and water move through the area. The MLR has developed a tool for prioritizing conservation land based on wildlife movements, wetland and riparian features, and projected developments.

Fisheries Overview for the West Gallatin River Watershed, Joe Naughton, Fisheries Biologist, RESPEC

Joe Naughton discussed the fishery in the upper Gallatin River watershed and how nutrient enrichment may affect the fishery. Data from Montana Fish, Wildlife and Parks indicated the Gallatin River has the highest angler pressure in the state, though there is less guide pressure than some of the other major rivers in southwest Montana. The fishery is dominated by non-native rainbow trout. Three salmonids are native to the upper Gallatin River: arctic grayling, westslope cutthroat trout, and mountain whitefish.

Grayling have been extirpated and westslope cutthroat trout inhabit a small portion of the watershed and most individuals are hybridized with rainbow trout. A 2002 study by Pat Byorth found that Gallatin River trout population were less affected by drought in the late 1990s than trout in other rivers in the state. The Gallatin River is a cold and nutrient poor system, with harsh winter conditions that limit trout recruitment and survival, so milder winters may be beneficial for rainbow trout. There were two paired fish sample sites with long-term data on the Gallatin River in the Gallatin Canyon: the Porcupine section located upstream from the confluence with the West Fork Gallatin River and the Jack Smith section located downstream from the confluence. These data indicate rainbow trout abundance nearly doubles below the West Fork confluence and that abundance has increased over time. Although there may be multiple other explanations for these trends, the influence of mild nutrient enrichment due to development within the West Fork Gallatin River watershed may be a plausible factor. Research in other river systems demonstrates that nutrient enrichment can alter the trophic dynamics of a river and the abundance and composition of the fish community, sometimes to the benefit of sportfish such as rainbow trout. For example, in the Bow River in Calgary, Alberta, moderate levels of nutrient enrichment (from numerous treated municipal effluents) has resulted in a 25-fold increase in rainbow trout biomass and a corresponding decrease in mountain whitefish biomass. At more extreme levels of nutrient enrichment (e.g., Silver Bow Creek in Butte, Montana), hypoxia may occur resulting in complete avoidance of an area by trout and other oxygen-sensitive aquatic life.

Protecting the Gallatin River's Outstanding Values, Scott Bosse, Director, Northern Rockies, American Rivers

Scott Bosse discussed the values of the Gallatin River, Taylor Fork and Porcupine Creek and why they deserve protection as Wild and Scenic rivers. For a river to be considered for Wild and Scenic designation, it must be free-flowing and have one or more outstanding river values, including fisheries values, wildlife values, recreational values, and scenic values. The Gallatin River system has native salmonids, with westslope cutthroat trout indicating the cleanest, coldest, highest value waters. Wildlife values include grizzly bears, elk, and big horn sheep. Recreational values contribute substantial economic benefits. Fishing (100,000 angler days/year, worth 40-52 million dollars a year), rafting (20,000 people commercially guided per year; 4.6 million dollars based on the 2006 EIS by DEQ for the Outstanding Resource Water designation), and hiking all contribute. Scenic values are also tremendously high on the Gallatin River. Montanans for Healthy Rivers citizen's proposal includes a package of rivers covering 700 river miles in 13 river systems in Montana. To make it an official Wild and Scenic River, it takes an act of Congress. If this is finalized, this designation protects free-flowing character, safeguards water quality, ensures sufficient flows, protects outstanding values, and requires development of comprehensive river management plan (on federal land and for federally-permitted activities).

Appendix C

Stakeholder Meeting Presentation Summaries: Water Supply and Availability September 2016

Presentations: Water Supply and Availability September 28, 2016 Stakeholder Meeting

Overview of Big Sky Water Supply and Availability, Jeff Dunn, Watershed Hydrologist, RESPEC

Jeff Dunn provided an overview of several topics relating to watershed hydrology, water supply and potential impacts of climate change. First, he gave an overview of the hydrologic cycle in which winter snowfalls in the Big Sky area provides for high streamflows during spring runoff. The Lone Mountain SNOTEL site (8,800 feet) has recorded variable precipitation over the 1992-2015 timeframe (annual precipitation ranging from 26.2"-42.9" with a mean of 33.7"), with increasing temperatures observed over this timeframe (mean daily temperature of 38°F in 2015). Gallatin streamflow has been recorded at the USGS Gallatin Gateway gage from 1930-present, with higher flows measured during spring runoff in the 1960's, 1970's and 1990's and lower flows during spring runoff in the 1930's, 1980's and 2000's. When comparing the period between 1930-1995 and 1995-2015, there is some evidence of higher runoff in May and June, with lower late-season flows in the past 20 years. High flow measurements conducted in the West Fork Gallatin River watershed estimated a peak flow of approximately 1,000 cfs in 2008 in the West Fork Gallatin River when the Gallatin mainstem was flowing approximately 6,000 cfs, indicating the West Fork Gallatin River watershed contributes approximate 15% of the Gallatin River mainstem flows during high water. Within the West Fork Gallatin River watershed, the Middle Fork West Fork Gallatin River peaks earliest and the South Fork West Fork Gallatin River peaks latest. Streamflow monitoring conducted by Montana DNRC in 2005-2007 indicate groundwater upwelling occurs in the Gallatin River mainstem within the vicinity of the West Fork Gallatin River confluence, contributing approximately 85 cfs during baseflow conditions. Water supply for the Big Sky area can be compartmentalized into four major "buckets", including the Big Sky Water and Sewer District (BSCWSD), Yellowstone Club (YC), Lone Mountain Land Company (LMLC), and Gallatin Canyon. Mean annual water production from the BSCWSD, YC, and LMLC is currently approximately 350 Million Gallons per Year. Water use is highest in the summer with projected increasing demand. Development can increase evapotranspiration and decrease infiltration as the amount of impervious surfaces increases. Dunn also gave an overview of climate change projections from several sources. Over time, regional climate models predict an increase in temperature, a range of possible trends in precipitation, and change from a snow driven climate to a transitional one with more rain by late in the century. Overall, the recommendation is to incorporate these factors into planning and management.

Water Rights: Big Sky Area Information, Kerri Strasheim, Regional Water Manager, Montana Department of Natural Resources and Conservation

Kerri Strasheim presented an overview on water rights and legal availability. Montana is a Western Doctrine state, so water use is "first in time, first in right" (not to be confused with the Eastern or Riparian Doctrine, where you can use it if you can access it!). People have been appropriating water since the 1860's, and surface water rights on the Gallatin River later than 1890 are essentially high flow, junior water rights. The Gallatin River is within the Upper Missouri River basin closure, while the Madison River is in the Jefferson and Madison Basin Closures. The bottom line is that new water rights are hard to get in these basins, unless they meet a permit exception. Hydropower dams in the Missouri River system were the largest factor resulting in the closure of these basins, though no one argues that the sources are over-allocated. Part of the Big Sky area is also in the Yellowstone Ground Water Control Area to protect geothermal features in Yellowstone National Park (NPS Compact – 1994). Downstream demands with senior water rights include hydropower and agricultural rights. In the Big Sky area at the time of this research in 2016, there are 638 active water rights with 120 statements of claim (historical water rights; 10 in Madison Basin; 110 in Gallatin Basin), 43 provisional permits, 444 groundwater certificates (exempt wells), 19 exempt notices, 7 water reservations (FWP), and 5 USFS Compact Water Rights – this illustrates

that not a lot of historical water use exists to mitigate new use. In addition, there are 17 pending water rights, with 15 pending groundwater certifications and 2 pending permits – this illustrates that growth is occurring. Overall, a rough estimate is about 88 cfs (12, 562 acre-feet) of water rights in the Big Sky area. Because the Big Sky area is in a closed basin, mitigation to provide a greater water supply will have to come from historical rights, with irrigation water rights typically providing the most water for mitigation. This creates a challenge in a mountainous area since there are very few existing water rights, compared to a valley area, where water can be used for mitigation by converting the water right from irrigation use as land-use changes. Any new groundwater withdrawals need to be mitigated “drop for drop” since 2005 (Smith River Decision) when all groundwater was determined to be connected to surface water (which is closed to new appropriation). In addition, any new subdivision developed after 2014 is allotted one exemption that allows the use of 10 acre-feet of groundwater without going through the permitting process. However, lots in existence prior to 2014 fall under the 1993 “physically manifold” rule that allows each lot to have its own well. As Big Sky grows, it has very limited options for “new” uses, due to the lack of mitigation water in the area around Big Sky. This is especially acute on the Gallatin side, but also present on the Madison side, though dam controlled water there makes it a little bit easier. Montana FWP instream flow rights are not always met – this is an indicator that water is not legally available in surface water sources in the area. In summary, balancing demands on water supply effectively requires strong, proactive planning.

Instream Flows and Water Policy Considerations, Patrick Byorth, Director of Montana Water Program Western Water and Habitat Project, Trout Unlimited

Pat Byorth described what’s important to think about with instream flows for fisheries, as well as information on mitigation and the potential for conservation and green infrastructure. First, he addressed the question of how much water fish need. Limiting factors for fish include: predation, water, food, climate, and winter habitat, with winter habitat being the most limiting factor. In the winter, fish need enough water to avoid any of the three kinds of ice: surface or pack ice, anchor ice, and frazzle or slush ice. Surface or pack ice can crush fish, so deep pools with enough water to avoid ice and enough water to float the ice are necessary. Anchor ice forms on rocks in riffles, so there needs to be enough water flowing over riffles to prevent anchor ice formation. Frazzle or slush ice can also kill fish since crystalline ice can get caught in gills and cause physical damage. Fish mortality can be significant in the winter, up to 40-60 percent. In the spring, fish need bankfull flows during spring runoff at least every other year. Bankfull stream flows recharge groundwater, re-create good instream habitat, mobilize sediment from the streambed, and deposit fines on the fringes of the channel where it makes soil for riparian vegetation to become established. In addition, most fish migration occurs during high water. In the summer, there needs to be enough water on the riffles to ensure oxygenation, provide for adequate aquatic insect production, and keep water cool. Temperatures of 65-70°F are stressful temperatures for trout. Deep pools provide cooler water and help fish avoid predators. There are several methods that have been used to calculate minimum flows necessary for fish, but all have some shortcomings. Instream Flow Reservations used by Montana FWP in Upper Missouri Basin are based on wetted perimeter method, which targets riffles at minimum flow to maintain aeration. Second, Pat address the question: “Is there any water left over for people?” Legally, the water has all been allocated, so the answer is “no”. However, mitigation is a way to share the water and make it legally available. There are three kinds of mitigation, including: 1) legal mitigation, which is the sale, transfer or lease of existing water rights; and 2) in-lieu fee wetlands mitigation under the Clean Water Act Section 404, which can be accomplished through a private mitigation bank and is driven by the permit process (Example: private mitigation bank on Hamilton Ranch in Twin Bridges). Clean Water Act Section 404 requires “no net loss of wetlands” and Pat recommended if you “break” a wetland in Big Sky, you should “fix” a wetland in Big Sky, since this creates the “sponge” that retains water in the watershed. There is also a third approach to mitigation that is less formal, but focuses

on conversation and green infrastructure to hold and slow the water across the landscape through ecological processes, such as improving pocket wetlands that had been drained by logging in the Big Sky area using beaver mimicry. The goal of this green infrastructure is to gather water, clean it, and discharge it to groundwater so that there is more water going out of the watershed more slowly.

Building Drought Resilient Communities in Montana, Ann Schwend, Watershed Planner, Montana Department of Natural Resources and Conservation

Ann Schwend discussed drought resiliency and community planning and framed “drought” as water planning. Drought is present anytime there is water scarcity, so it isn’t just lack of precipitation but also anytime there is not enough water to meet all demands. Planning is important because we all have a water budget we have to live within. Legally, we don’t have enough water in the basins and climate variability and drought are both shifting the dynamics of water availability and timing. A water budget is much like a household budget; resources can be allocated to one place or another, but it has to be done within the confines of the total available. In a headwaters area with a snowmelt driven system, how do we set water aside during times of high water during spring runoff? Using our natural system to slow water down in the headwaters is like a savings account. Once the water goes downstream, it is no longer available for the community. The Montana Drought Resilience Partnership Demonstration Project in the Upper Missouri River Basin is designed to leverage and deliver resources, engage communities, and implement projects. This approach will develop local and regional capacity to plan for drought. Community drought planning will help develop an understanding of supply and demand, a vulnerability assessment, an emergency response plan, and mitigation strategies. Individual watersheds are developing plans that will roll up and be included in a headwaters basin level plan, including the drought resiliency plan for the Upper Gallatin. In addition, the State Water Plan supports shallow aquifer recharge and identifies ideal locations as natural wetland and riparian areas that promote restoration of floodplain functionality.

Groundwater Conditions – Big Sky MT, Mike Richter, Research Specialist, Montana Bureau of Mines and Geology

Mike Richter described groundwater conditions in the Big Sky area. Prior to 1993, there were about ten wells drilled per year. There was a rapid uptick in groundwater wells drilled for drinking water (domestic and public water supplies) in the early to mid-1990s. Four factors seem to have contributed: the movie *A River Runs Through It*, Big Sky Resort installed the tram, Ron Edwards came on at the Big Sky County Water and Sewer District (BSCWSD), the building moratorium was ended, and the exempt well “loophole” allowed an avenue for the development of smaller wells. MBMG has twelve long-term sites and three springs it monitors in the Big Sky area, with data collection starting in 2008, so about 8 years of data. The geology in the Big Sky area is quite diverse, including sand and gravel alluvial aquifers, sandstone and shale aquifers (Cretaceous sediments), Madison Limestone aquifers, and fractured bedrock aquifers. Sand and gravel alluvial aquifers have the best quality water, but are the least common in the area. These alluvial aquifers were formed when sand, gravel and cobbles eroded from mountains and deposited in the basins, and include the Meadow Village aquifer from which the BSCSWD draws much of its water supply. Sandstone and shale aquifers, which surround the Meadow Village area, have marginal water quantity and water quality, typically having elevated pH and mineral content (iron, sulfur, etc.). The Madison Limestone is a great aquifer, but is only available at junction of HWY 64 and 191 and south of Big Sky near Red Cliff campground, and is otherwise buried very deeply (~4,000 feet below Meadow Village) and is inaccessible for drinking water wells. Fracture bedrock aquifers are found in the Gallatin Canyon and in the Mountain Village. In the Mountain Village, these aquifers are made up of intrusive basites, which create a decent aquifer fed by recharge coming off of Lone Peak. The Meadow Village aquifer is a small, great aquifer that is relatively shallow. The Meadow Village aquifer is recharged by groundwater and surface water during seasonal snowmelt at the western end and northwestern end, with contributions from the North Fork

West Fork Gallatin River, Middle Fork West Fork Gallatin River and Crail Creek. The Meadow Village aquifer becomes connected to the West Fork Gallatin River as it flows through Big Sky Golf Course and starts to discharge water to the channel and springs. There is a 49 foot deep monitoring well in deep part of aquifer. Most of the aquifer is 10-30 feet thick, though the deepest trough is 50-60 feet deep and is located north of the West Fork Gallatin River, which is where BSCWSD has five public water supply wells. Water levels in the Meadow Village aquifer vary from 5 to 15 feet below ground surface, so this aquifer is vulnerable to surface contamination. The Meadow Village aquifer has very good water quality with <500mg/L total dissolved solids (TDS) and nitrate concentrations of 1-2 mg/L in the deeper parts of the aquifer. At the fringe of aquifer where it is only 15-20 feet thick and underlies the Big Sky Golf Course, nitrate concentrations as high as 5mg/L have been recorded. Snowmelt causes a yearly pulse in groundwater in the spring, which is followed by a second pulse in groundwater elevations in the fall as “artificial recharge” is contributed due to golf course irrigation. A new water supply well online in summer 2016 generating a new amount of groundwater withdrawal creating greater demand on the Meadow Village aquifer.

Groundwater Conditions – Big Sky MT Ground Water Investigations Monitoring, James Rose, Hydrogeologist, Montana Bureau of Mines and Geology

James Rose presented information on the MBMG Ground Water Investigation Program (GWIP) that is investigating groundwater availability and water chemistry at Big Sky. Preliminary results identified nine aquifers (water-bearing geologic units) in the Big Sky area. GWIP staff monitored and sampled each aquifer using existing water wells with permission from resident well owners and water systems managers. For the project, GWIP located and inventoried one hundred and fifteen wells in the Big Sky area as representative of most wells at Big Sky. From 2013 to 2016, GWIP monitored water levels in 67 wells and measured discharge at 28 stream and river sites. Water chemistry samples collected from 43 wells and 6 stream sites helped define the aquifer systems and assess groundwater/surface-water interactions.

A special focus of the investigation is on the Meadow Village Aquifer, the largest public water supply source in the area. Growth of Big Sky will depend upon a sustainable public water supply source from this aquifer. The MBMG-GWIP study will determine the sustainable water capacity of the aquifer.

The Meadow Village Aquifer is a shallow sand and gravel valley fill that covers approximately two square miles, mostly beneath the Meadow Village Golf Course. At the base of the aquifer is a relatively impermeable shale. Fifteen monitoring wells were installed in the west half of the aquifer area to determine the type of aquifer material (sand, silt, or gravel), water levels, and the depth to the shale that defines the aquifer bottom. Preliminary results indicate the aquifer is thinner on the edges and is deepest along an east west trough along the northern edge of the aquifer, where the Big Sky Water and Sewer District (BSWSD) wells are located.

Preliminary investigations suggest the Meadow Village Aquifer appears to be interconnected with the West Fork Gallatin River, with alternating gaining and losing reaches and exchange of water occurring throughout the system. At the western end of the aquifer, the West Fork Gallatin River is at higher elevation than groundwater, thus the stream is likely recharging the aquifer in this area (near the Two Moons road bridge). At the eastern end of the aquifer near the Crail Ranch Homestead, the river level is below groundwater levels in nearby monitoring wells, suggesting groundwater is discharging from the aquifer into the stream.

As part of the investigation, MBMG-GWIP is constructing a computer-based groundwater model of the Meadow Village Aquifer to evaluate groundwater availability. The model will provide the means to test options and alternatives for management of future groundwater withdrawals, while maintaining a

sustainable groundwater supply source.

Water Quality in the Big Sky Area, Peter Manka, Principle Water Resources Engineer, Alpine Water

Peter Manka discussed water quality in the Big Sky area water supplies. In the BSCWSD, there are approximately 2,000 service connections, with approximately 1,300 in the Meadow Village Area and approximately 700 in the Mountain Village Area. The BSCWSD provides approximately 250 Million Gallons per Year (MGY) to their customers. This water is high quality, though does have elevated calcium concentration, which is commonly known as “lime scale” or “hard” water. To address concerns with “lime scale”, homeowners often use ion exchange (salt or potassium) water softeners. In these systems, each mg/L of hardness is replaced with mg/L of salt. As a result, these salt water softeners contribute high chloride levels which then enter the wastewater system. Assuming 25% of 2,000 BSCWSD customers (500) have an ion exchange softener would lead to an estimated 4 million gallons of water wasted per year treating the water and an estimated 40 million gallons of salt water discharged to sewer system, which is approximately 30% of the 120 million gallons of sewage BSCWSD treats annually. Some cities and municipalities have restricted or banned the use of salt water softeners due to the high quantities of water required, along with the treatment requirements and the impact of chloride discharged into the environment following treatment. Outside of the BSCWSD, there are a handful of public water supplies, including Ophir School, Ram’s Horn Subdivision, Antler Ridge Estates, Yellowstone Club, and Moonlight Basin. Everyone else relies on private, unregulated water systems, of which there are about 300 private water systems in the Big Sky area. Water quality concerns in these private systems include iron, low pH (~6.5), sulfides and even arsenic in some locations. Options for addressing most taste, smell and health-related constituents include ozone, acid neutralization, aeration, ultrafiltration, and reverse osmosis. Peter indicated that reverse osmosis should never be used for whole-house or commercial systems due to the extremely high amount of water used during treatment. Peter also pointed out the need for individual well testing and the development of a database to track water quality issues in private wells so that landowners and the community can ensure that appropriate measures are taken for both existing and newly constructed private water systems.

Appendix D

Stakeholder Meeting Presentation Summaries: Wastewater Treatment and Reuse November 2016

Presentations: Wastewater Treatment and Reuse November 3, 2016 Stakeholder Meeting

Big Sky County Water & Sewer District Overview, Ron Edwards, General Manager, Big Sky County Water & Sewer District

Ron Edwards presented an overview of the operations of the Big Sky County Water and Sewer District (BSCWSD), which was created in 1993 after a public vote and is governed by special provision under Montana statutes Title 7, Chapter 12, Part 22 and 23. The BSCWSD board has five elected members and two members appointed by Gallatin and Madison counties. BSCWSD has rate setting, taxing and bonding authorities, and eminent domain powers, though it has never used its eminent domain powers. BSCWSD service areas include the Mountain Village, Meadow Village, Lone Moose Meadows, and Spanish Peaks. The BSCWSD water system has nine storage tanks and fourteen wells. A pipeline connecting the Mountain Village to the Meadow Village was built in 2006 and provides the ability to feed potable water from mountain to meadow. Summer demand is up to eight times that of winter demand, primarily due to irrigation. While the BSCWSD covers much of the Big Sky area, Moonlight Basin and Yellowstone Club have separate systems. As of 2016, the BSCWSD has about 2,600 customers (billable accounts) and the service area is estimated to be about 45% built-out. Most of the BSCWSD service area is residential and there are more condos than single family homes, which is a unique situation. There is a water meter on every home and most of the condo units, which is an effective tool for billing and management. There are many undeveloped lots within the BSCWSD service area which the district is legally obligated to provide water and wastewater service to. Single Family Equivalents (SFEs) are the basis for permitting and tracking new development. Residential SFEs are based on square footage, while other purposes, such as commercial, use conversion formulas based on the type of development and square footage. Restaurants and delis use seating capacity. The number of SFEs has increased over time, from approximately 1,500 in 1990 to approximately 5,200 in 2016. Since 1996, SFEs have increased by an average of 5% in within the BSCWSD and there is additional growth occurring outside of the BSCWSD. 2016 is a record year and includes the newly permitted, but as yet unbuilt, Lodge project in Spanish Peaks. December 31st is the biggest day of the year for wastewater generation, with roughly 700,000 gallons/day, compared to an average of 390,000 gallons/day. Big snow fall years that result in high spring runoff rates can also lead to comparable wastewater plant inflows. BSCWSD is expecting to treat approximately 140 Million Gallons (MG) of wastewater in 2016.

Wastewater is first processed in the headworks, then a Sequencing Batch Reactor (SBR), which treats water in batches and works well with the big swings in flow that occur seasonally due to changes in visitation. Following tertiary treatment and chlorine disinfection, the water is stored in an irrigation storage pond, where it is held over the winter and then used for land application on the Big Sky Golf Course between May and October. Treated wastewater is also pumped up a 7.2 mile long force main pipeline to the Yellowstone Club's 80 MG storage pond where it is applied to their golf courses during the growing season. Spanish Peaks has constructed a new 15 million gallon lined storage pond which will come on line the fall of 2017. Treated water will be disposed on the Spanish Peaks Golf Course for the first time in the summer of 2018.

Sludge is composted and the compost is sold locally. Storage of wastewater started in the 1970's and was expanded in 1996. Irrigation capacity depends on the number of days, soil type, precipitation and weather. Irrigation capacity is based on the wettest year in 10, which is estimated at 143.3 MGY on the Big Sky Golf Course over a 137 day irrigation season. As more growth occurs, disposal using the current land area will not provide enough capacity, especially during wet years. The biggest issue facing the

BSCWSD is disposal, with an estimated 119-155 MGY shortfall due to a lack of irrigable area at full build-out based on a projected wastewater flow of 313.8 MGY. In 1998, the BSCWSD had a direct surface water discharge permit of 15 MG during peak runoff, but let that permit lapse in 2008 without using it, and never constructed a pipeline to the river. There are many possible options for wastewater disposal including expanded irrigation, groundwater discharge (engineered drain fields), snowmaking, surface discharge, smaller decentralized treatment plants, a combination of all, and other ideas.

Yellowstone Club Overview, Mike DuCuennois, Vice president of Development, Yellowstone Club

Mike DuCuennois presented an overview of development, water supply and wastewater treatment at the Yellowstone Club, which has its own water supply and wastewater treatment systems, but is also intertwined with the BSCWSD. The 30 Million Gallon (MG) pond breach in March of 2016 included 25 MG of BSCWSD water. The Yellowstone Club has 864 total residential memberships approved in the 1999 master plan. Approximately half of these are single family homes and half are condos. There are currently 578 memberships. The Yellowstone Club is building a new lodge which is 550,000 square feet and is one of the biggest project in Montana history. The Yellowstone Club has built a new SBR wastewater treatment plant for the lodge which is fully operational. Currently, the Yellowstone Club generates about 20,000 Gallons per Day of wastewater and anticipates generating about 20 Million Gallons per Year (MGY) at full build-out. The Yellowstone Club Golf course irrigation can utilize about 25 MGY of treated wastewater. There is an emphasis on water resource conservation: all connections are metered, there are summer irrigation restrictions (allotment of 405 gallons/day for house/landscaping), architectural guidelines include drought tolerant plantings, a graduated water pricing structure, and annual leak detections.

Moonlight Basin Water and Wastewater Overview, Kevin Germain, Vice President of Planning and Development, Lone Mountain Land Company

Kevin Germain presented an overview of development, water supply and wastewater treatment at Moonlight Basin. In 1992, Moonlight Basin purchased a 25,000 acre parcel. The goal was to have 80-85% of the original purchase protected in conservation easements since the Jack Creek area provides a critical link to the wilderness sections north and south of the original purchase. 17,000 acres have been sold to conservation buyers and 14,500 acres are under conservation easement. The remaining 8,000 acres are under development. Land use planning is constraints-based and areas least sensitive to development have been identified. Currently, Moonlight Basin is 25% built out, with 414 platted lots out of a total of 1,650 total lots. 95% of Moonlight Basin is in the Jack Creek watershed. Madison Conservation District and the Jack Creek Preserve Foundation have been conducting water quality monitoring on Jack Creek for the past 10 years. There are two water systems within Moonlight: east and west. Water demand is highest in the summer due to irrigation, which provides opportunities for conservation. Water demand reduction methods include using reclaimed water, xeriscaping with drought tolerant plants, rainwater harvesting off rooftops for summer irrigation, and snowmaking. Moonlight Basin has a high flow water right (May 25-June 25) out of Lone Creek that is currently used for irrigating the golf course. As they transition to irrigating the golf course with reclaimed water, they would like to change their irrigation water right to a snowmaking water right by capturing the water during spring runoff and storing it for snowmaking in the winter. Moonlight Basin has received a mitigation water right from the Jumping Horse Ranch downstream, which was paid to retire acres from irrigation and leave the water in Jack Creek to offset consumption at Moonlight Basin. There currently is a wastewater treatment system in place that is an oxidation ditch and a new Membrane Bioreactor (MBR) plant is slated for completion by the end of 2017. Approximately 90% of the units are served by

central sewer and water, while the remaining units are on individual well and septic. Wastewater generation peaks in the winter, dips in shoulder season and picks up in the summer. For future water use projections, Moonlight Basin is looking at other resort communities that are further along in their development, with increasing occupancy rates anticipated as the resort matures. At full build out, it is conservatively estimated that 113.4 Million Gallons per Year (MGY) of treated wastewater will be generated. The Moonlight Basin Golf Course can utilize 19.5 MG on a wet year and 52.1 MG on a dry year, which results in a deficit of 61.3 MGY to 93.9 MGY for disposal through some other means than golf course irrigation. Currently, Moonlight Basin land applies effluent to a 17 acre forested site in the summer and anticipates needing 60-70 acres of forest to land apply the excess 90 MG of treated wastewater. Disposal options for the future include land application at a rate that is 100% consumptive and other re-use options that may better conserve the water resource.

Canyon Area Overview, David O'Connor, Buck's T-4

David O'Connor discussed the Canyon, which is not part of any of the entities previously discussed and operates like most of rural Montana, primarily on well and septic systems. There are several minor water systems including the trailer court, Buck's T-4, Ophir School, Ramshorn, Lazy J South, Whitewater Inn, and the Corral. There is no common element that ties the Canyon together – no single political entity (school district, fire district), little data, no studies and reports, and no common element that applies to the entire Canyon area. Buck's T-4 has one of the bigger systems with three lagoons and 6 acres for irrigation disposal and represents the closest thing to the type of wastewater treatment done in the previously discussed examples. Tying the Canyon into the BSCWSD would take significant dollars and would require addressing infrastructure issues and the obtaining the community's support. In 2008, a study looked at what type of flows the BSCWSD would take on the Canyon and estimated it would be 1 Million Gallons per Day at full build-out. This is significantly larger than the projected peak flow at full build-out within the existing BSCWSD. In addition, the high building densities zoned in the Canyon likely can't be built using individual septic and well systems.

Workforce Housing Needs Overview, Kevin Germain, Vice President of Planning and Development, Lone Mountain Land Company

Kevin Germain presented on workforce housing needs. The Big Sky Chamber of Commerce subcommittee completed a study in 2014 looking at workforce housing. There are 2,300 workers in the Big Sky area and 1,900 workers (83%) of the workforce lives outside of Big Sky area and commutes in every day. The biggest limitation to living in the Big Sky area is cost. The workforce is most likely to live in the Meadow Village or the Gallatin Canyon. Both areas have limitations associated with water resources. In order to solve community housing needs, we will need to address water and wastewater needs. As the community grows, the need for workforce housing won't be linear, due to economies of scale. There is a goal to have 60% of the workforce living in the community based on other mature resort areas. Based on this goal, there is a 600 unit shortage in housing as of 2014, so it's even greater today.

Big Sky Area Septic System Overview, Tom Moore, Environmental Health Specialist, Septic Division, Gallatin City-County Health Department

Tom Moore discussed sanitary septic systems and relayed that public health advances in this area directly relate to advances in quality and longevity of life along with environmental health. Public wastewater (and water) systems are any systems that serve 25 or more people for at least 60 days of the year, while individual septic systems serve individual residences. A total of 17,501 septic permits were issued by Gallatin County over a 50-year period between 1966 and 2016, with 963 septic permits

issued in the Big Sky area (Karst to the Corral) during that timeframe. In the Big Sky area, there were bumps in septic permits in 1973 when the lifts started running and when the building moratorium occurred in 1993. Early Gallatin County septic permits in the Big Sky area did not have precise locations, lacked soil information, and lacked information on the location of the nearest surface water. Current septic permits are much more detailed, but many of those old systems are still in place. State law on non-degradation and mixing zones require the wastewater, which mixes with underground water, to meet State drinking water standards for nitrates and phosphorus by the time it reaches the surface water. A dilution model is also required now. Neither of these were required on the older permits. In sensitive areas, such as the Beaver Creek drainage, Level 2 (“tertiary”) treatment methods are required, which are significantly more expensive, costing up to \$40,000-\$50,000. However, these Level 2 septic systems don’t work well when they are used sporadically, as they often are with second homes. One advantage of public water and wastewater systems is that there is regular maintenance and testing, while individual septic systems rely on the landowner for upkeep and monitoring. In addition, many small systems do have cumulative impacts. In the Gallatin Valley, the Gallatin Local Water Quality District found pharmaceuticals and hormones in more than 90% of the wells tested in the valley due to well and septic interactions. There are creative options for enhancing responsible on-site septic use including advanced septic design, homeowner education, such as what the GRTF has done, and required septic inspection when homes are sold.

Municipal Wastewater Treatment Regulations, Disposal Regulations, and Funding, Todd Teegarden, Engineering Bureau Chief, Water Quality Division, Department of Environmental Quality

Todd Teegarden discussed DEQ’s role in oversight of municipal and community public wastewater treatment, including systems like the Big Sky County Water and Sewer District. Treatment options include onsite treatment (septic systems), facultative lagoons, aerated lagoons, and mechanical plants. If discharge is a point source to waters of the State, then a discharge permit is needed. Groundwater (for discharge greater than >5,000 gpd) and surface water discharge permits are required for certain uses. Permits are not required for total containment or for fully consumed water reclamation and reuse like landscape irrigation. From a water quality standpoint, considerations include mixing zones, water quality standards, non-degradation, groundwater, and storm water. DEQ design circulars, guidance and other information are readily available to help. DEQ also has some funding available to help with wastewater treatment infrastructure. These include the Drinking Water and Water Pollution Control State Revolving Funds, which support drinking water and wastewater pollution control projects. There is also a Drinking Water State Revolving Fund (DWSRF) with funding available.

Connections to Ecological Impairments and Overview of Treatment and Disposal Options, Jeff Dunn, Watershed Hydrologist, RESPEC

Jeff Dunn discussed existing ecological impairments to streams in the West Fork Gallatin River watershed and presented an overview of wastewater treatment and disposal options. A Total Maximum Daily Load (TMDL) is the maximum amount of a pollutant a water body can receive and still meet State waters quality standards. The West Fork Gallatin River TMDL was completed in 2010 and a Watershed Restoration Plan (WRP) was completed in 2012. In the Big Sky area, there are nutrient TMDLs for three impaired stream segments, including the West Fork Gallatin River (33% reduction required for nitrate+nitrite and 36% reduction required for total nitrogen upstream of the confluence with the South Fork West Fork Gallatin River), Middle Fork West Fork Gallatin River (33% reduction required for nitrate+nitrite upstream of Lake Levinsky), and South Fork West Fork Gallatin River (TMDL reductions not calculated). Nutrient TMDL targets of ≤ 0.100 mg/L for nitrate+nitrite and ≤ 0.320 mg/L for total

nitrogen are established for the summer months extending from July 1st through September 30th since excess nutrient concentrations can lead to undesirable algae growth and impair a stream's recreational and aquatic life beneficial uses. Nutrient source categories identified in the TMDL include natural background, residential and resort landscape management and maintenance, on-site septic systems, and unpermitted wastewater due to spray-irrigation of wastewater and potential sewer or service line disruptions. For *E. coli*, TMDL targets of 126 cfu/mL in the summer (April 1-October 31) and 630 cfu/mL the winter (November 1-March 31) are established since elevated instream concentrations of pathogenic pollutants put humans at risk for contracting water-borne illnesses and impair a stream's recreational uses. *E. coli* source categories identified in TMDL include domestic pets, livestock, wildlife and waterfowl, stormwater runoff from streets, parking lots and other impervious surfaces, failing or malfunctioning septic systems, and broken sewer lines or domestic service lines. Some options for wastewater disposal include land application (irrigating the golf courses), surface water discharge, snowmaking, constructed wetlands, and deep well injection.

Appendix E

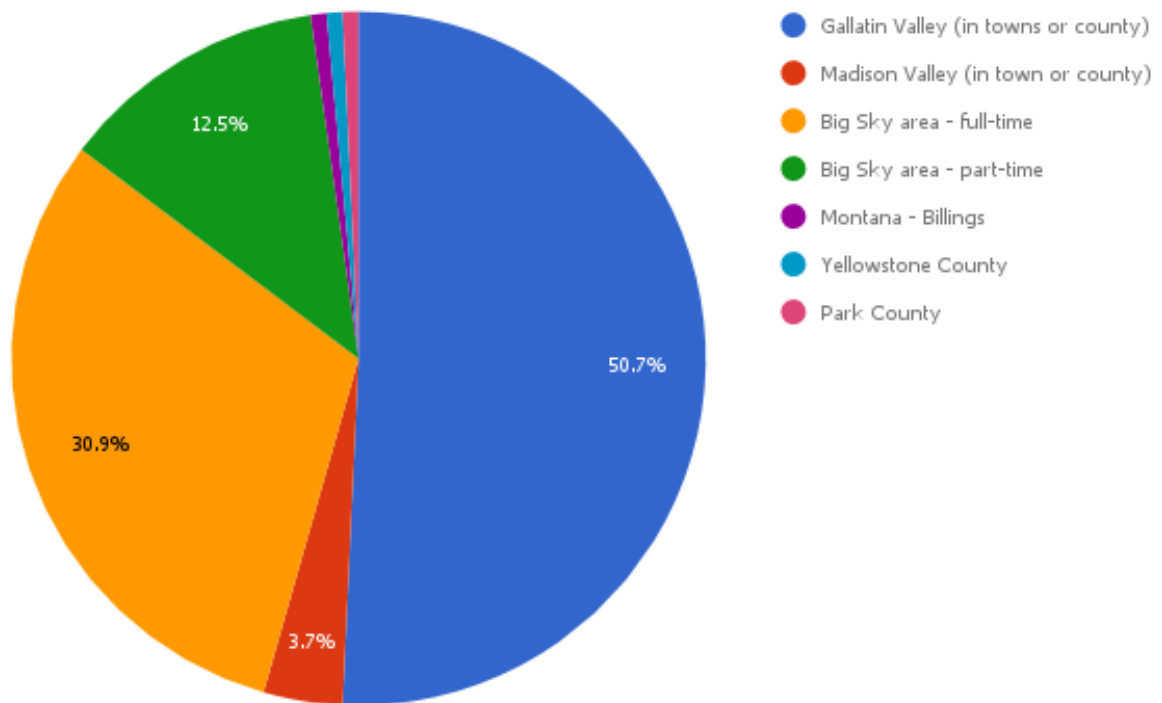
**Big Sky Sustainable Water Solutions Forum
Community Water Resources Survey
August – September 2017**

Big Sky Sustainable Water Solutions Forum Community Survey

August - September 2017

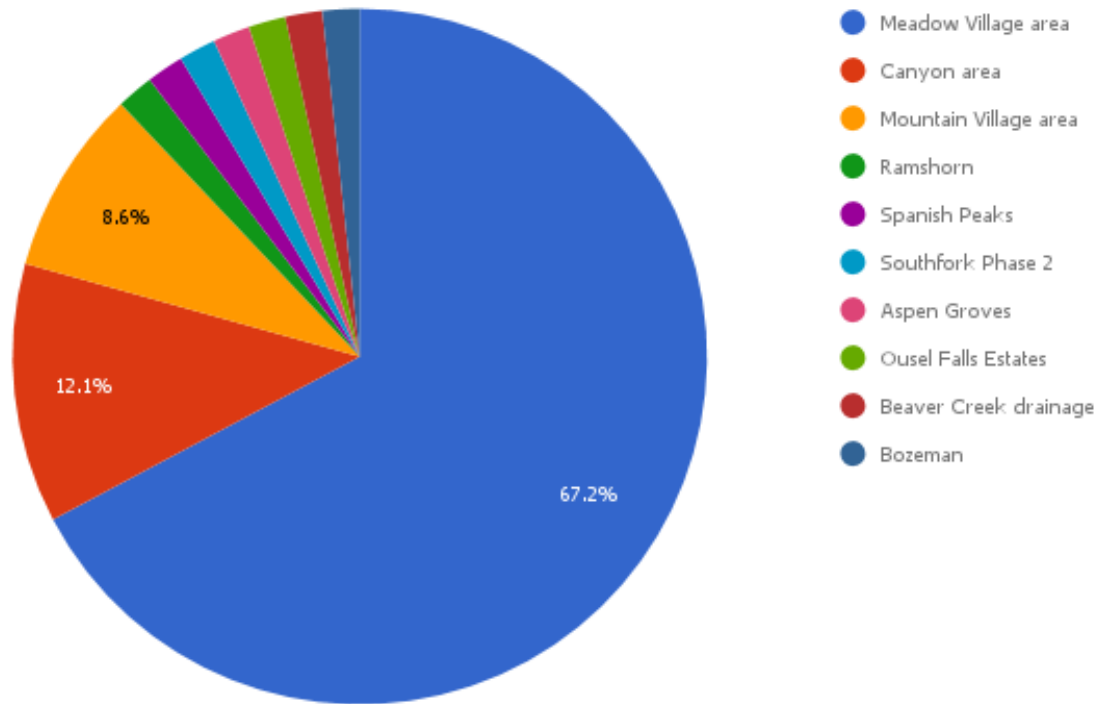
The Big Sky Sustainable Water Solutions Forum conducted a community survey between August 3 and September 24, 2017. 137 responses were recorded. The survey was distributed electronically, via links published on the Gallatin River Task Force web site, the Big Sky Sustainable Water Solutions Forum project page, emails to stakeholders, emails to a list of interested public, via a link in a letter to the editor in *Explore Big Sky*, the bozone-orgs listserv and through newsletters and forwarded emails from stakeholders to their members or colleagues. The results of this survey will be used to inform the Big Sky Sustainable Water Solutions Forum about community interest and opinions on the preliminary priorities that had been identified in June of 2017. This information will be used to help shape the final recommendations and priorities chosen.

1. Where do you live? 136 respondents



2. If you live in Big Sky, where do you live in Big Sky?

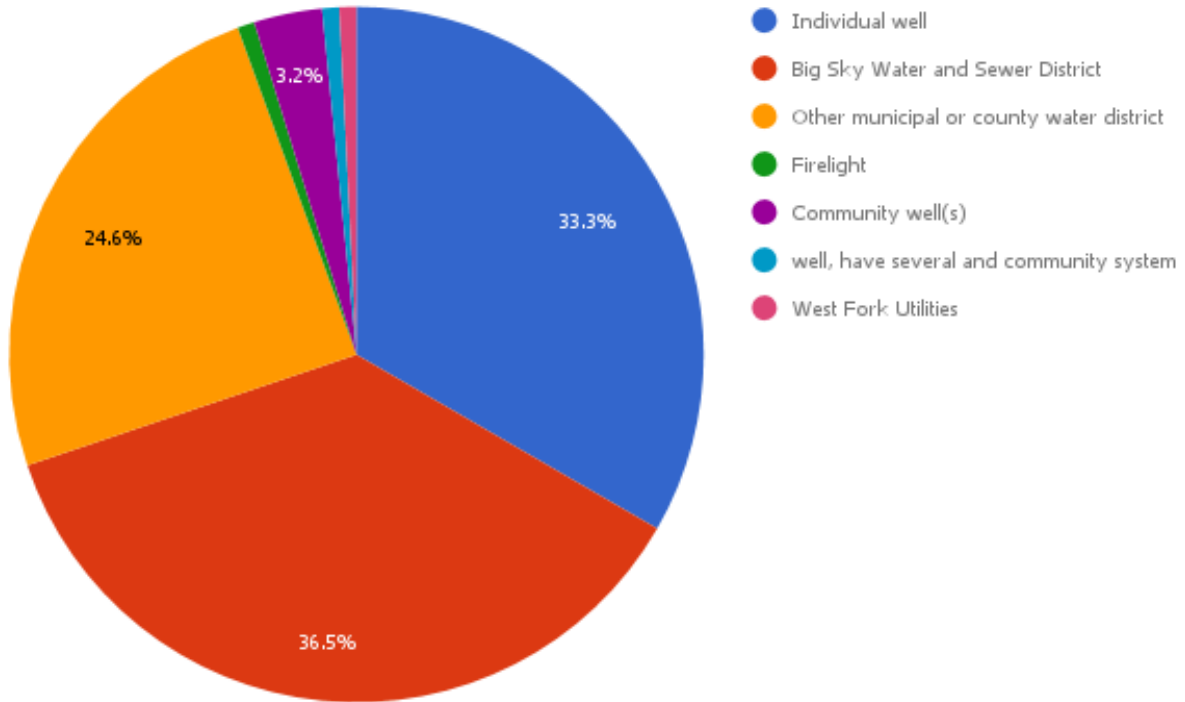
58 responses



One respondent to this question reported living in Bozeman. In that case, 57 people who responded actually live in Big Sky full or part time. Original options for responses were “Meadow Village,” “Mountain Village,” Canyon Area, Moonlight, Spanish Peaks, Yellowstone Club or “Other” with an invitation to fill that in. From responses gathered, it is clear that many people are very precise and identify their location within a particular subdivision.

3. Where does the water you use at your house come from?

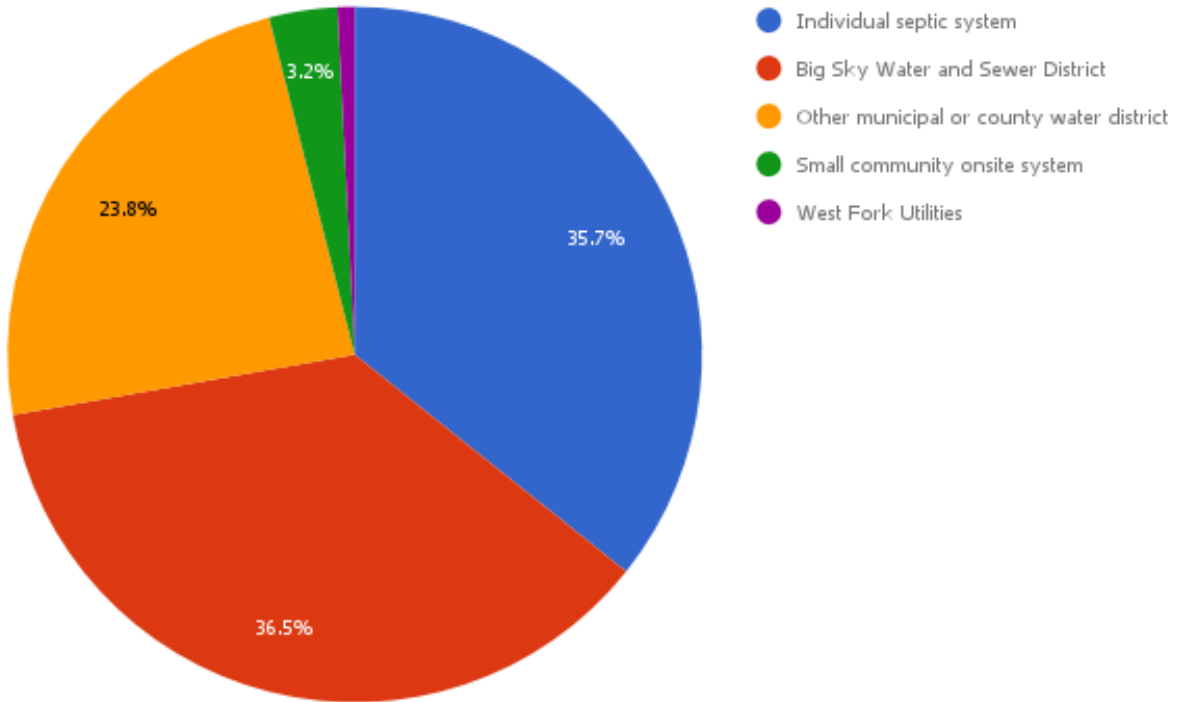
127 responses



93% of respondents did respond. This question covered both Big Sky and the surrounding zone of influence. It does appear that the vast majority of respondents do know the source of their water supply.

4. Where does the water you use at your house go after your use it?

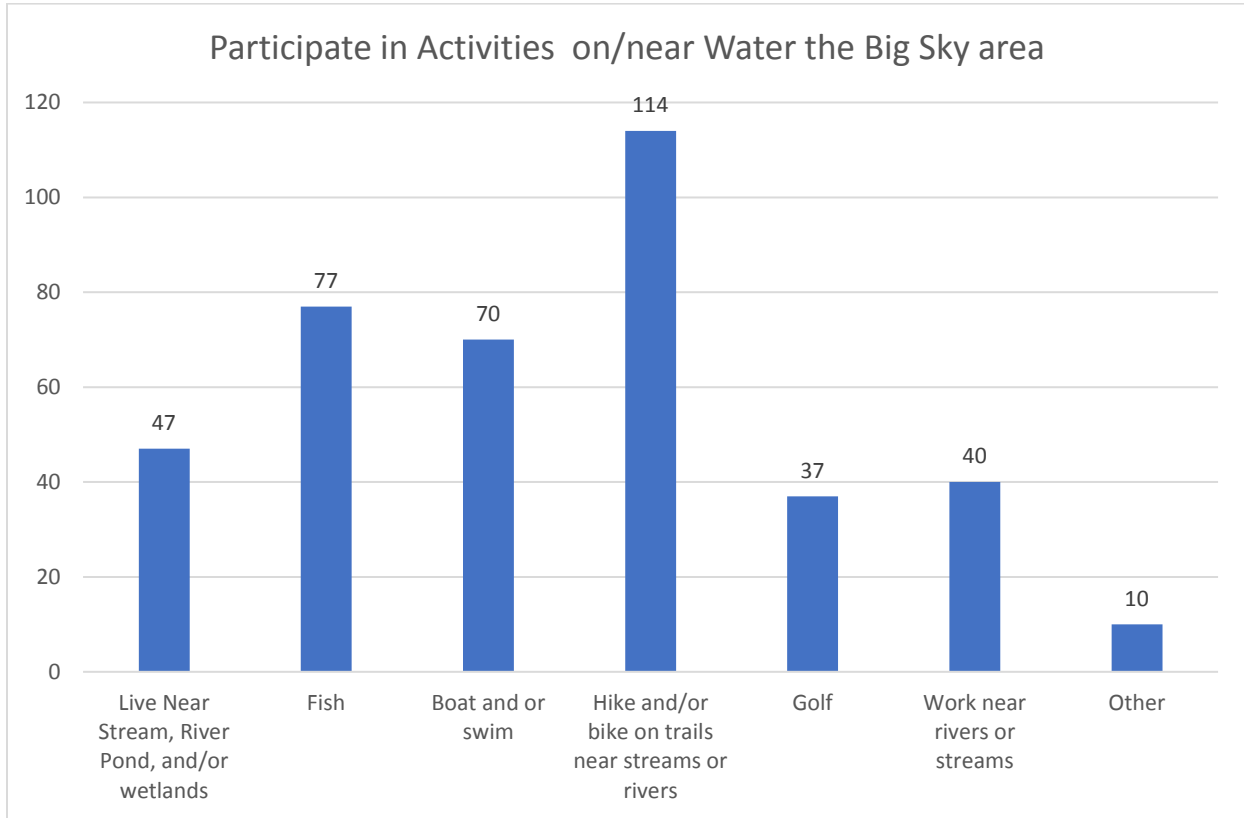
127 responses



Again 93% of respondents answered this question. It does appear that the majority of respondents are on some kind of system that they do not manage themselves, a sizable minority (35.7%) do have individual septic systems.

5. Which of the following activities do you do in the Big Sky area on or near rivers or wetlands?
(choose all that apply)

129 responses (respondents could choose multiple responses to question)

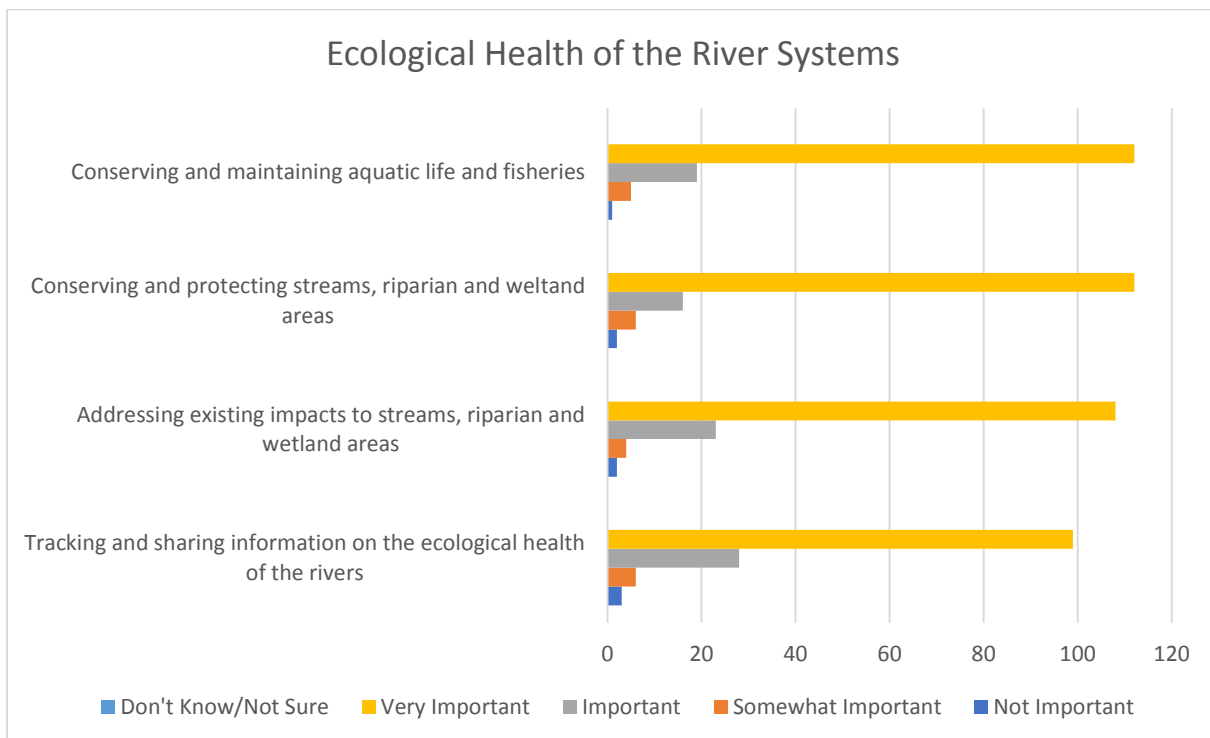


Priorities

The next section is a set of questions pertaining to the three focus areas for the Big Sky Sustainable Water Solutions Forum. Preliminary priorities identified in the three focus areas in June of 2017 were used as the basis for the selected questions. In addition, respondents were given an opportunity to write in ideas or concerns.

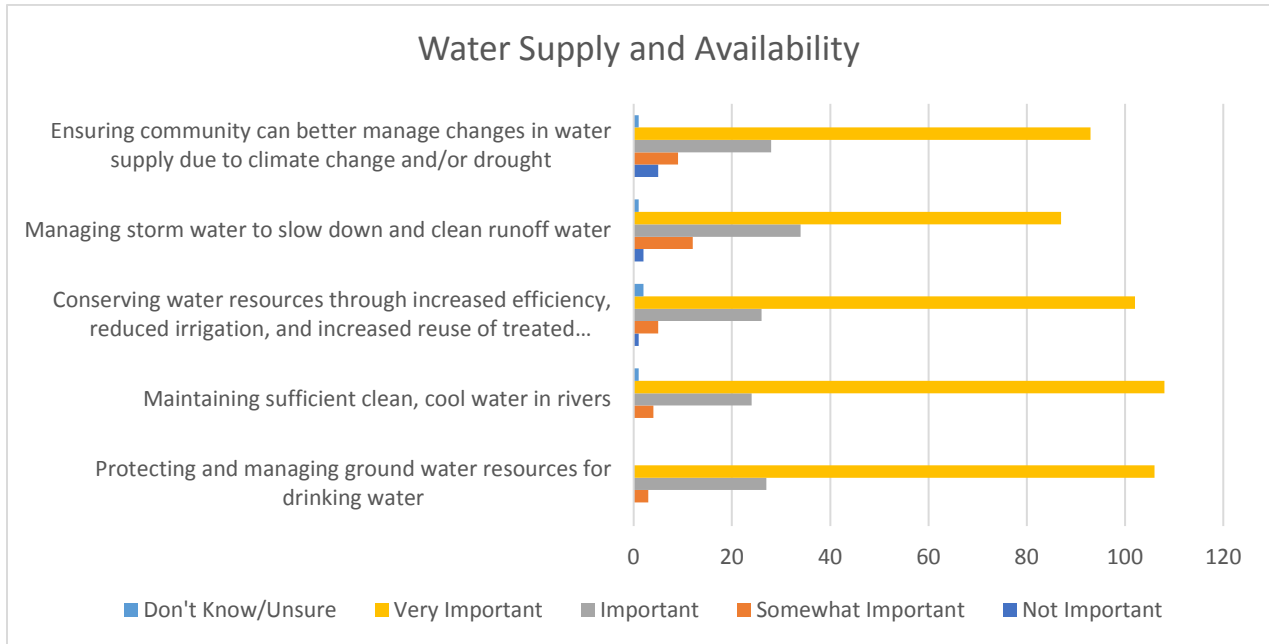
6. Ecological Health of the River Systems Priorities

137 responses (not all replied to all priorities)



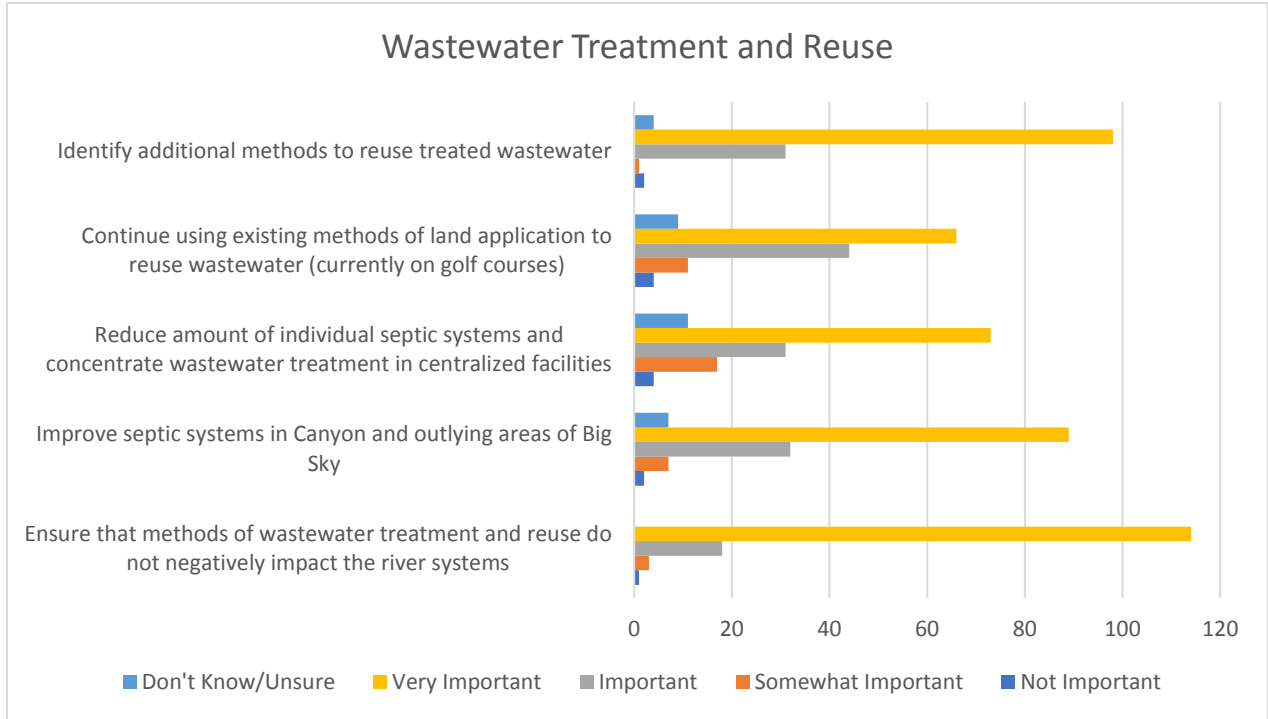
7. Water Supply and Availability Priorities

136 responses (not all replied to all priorities)



8. Wastewater Treatment and Reuse Priorities

137 responses (not all replied to all responses)



9. Other concerns and priorities for the three focus areas.

Responses:

Ecological Health of River Systems: 38

Water Supply and Availability: 40

Wastewater Treatment and Reuse: 56

For each focus area, respondents were asked an open-ended question about their concerns and priorities in that area. There was a great deal of overlap in responses between the three areas. Several respondents also listed several issues in their responses, so each topic was counted separately, resulting in a higher total than the total number of responses. In a few cases, there were factually incorrect responses on ownership, infrastructure, or other issues. In these cases, the topic that they applied to were counted, but these also suggest that more public education and outreach could be used on those topics.

Open-Ended Question Responses, by Topic			
Area of Concern or Priority	Focus Area		
	Ecological Health of River Systems	Water Supply and Availability	Wastewater Treatment and Reuse
Ecological Health of River Systems	12	4	9
Water Supply and Availability	7	24	5
Wastewater Treatment and Reuse	7	2	31
Drought/Climate Change	2	1	0
Organizational/Institutional Issues	4	1	5
Education, Outreach, and Public Relations	2	3	2
Economics and Growth	5	7	6
Accountability and Transparency	4	0	8
Other	5	3	1

Ecological Health of River Systems: Water quality, current and potential impacts to fisheries, and damages from human activities and pollutants were the major areas listed.

Water Supply and Availability: Limits to surface water and groundwater supply, water conservation, water rights, types of water use, and improvement in knowledge about water resources were major areas listed.

Wastewater Treatment and Reuse: Effluent discharge and untreated wastewater spills were the most frequently cited concerns, but there were responses in support of future surface water discharge. Septic systems, treatment levels, pollutants, and ideas and questions about alternatives for reuse other than direct surface water discharge were the other major topics identified.

Drought/Climate Change: Respondents either thought this was an additional issue or, in one case, thought climate change was not relevant or real.

Organizational/Institutional Issues: Issues of ownership, fragmentation and opinions about organizational missions, duties, decisions or contractual obligations were expressed here.

Education, Outreach, and Public Relations: Ideas for further education and outreach were expressed, as well as thought on “bad PR” on the option of direct surface discharge to the river.

Economics and Growth: Concerns about the impact of growth, current capacity to handle growth, as well as a concern that decisions might affect the ability for continued growth and economic development or impact private property rights were expressed here.

Accountability and Transparency: Concerns on ability to know about, oversee, or limit impacts, particularly to the rivers were the main concern areas.

Other: Impacts to downstream users were recorded. Impacts to river systems by recreational users and visitors were also recorded.

10. If you could do one thing to improve water resources, what would it be?

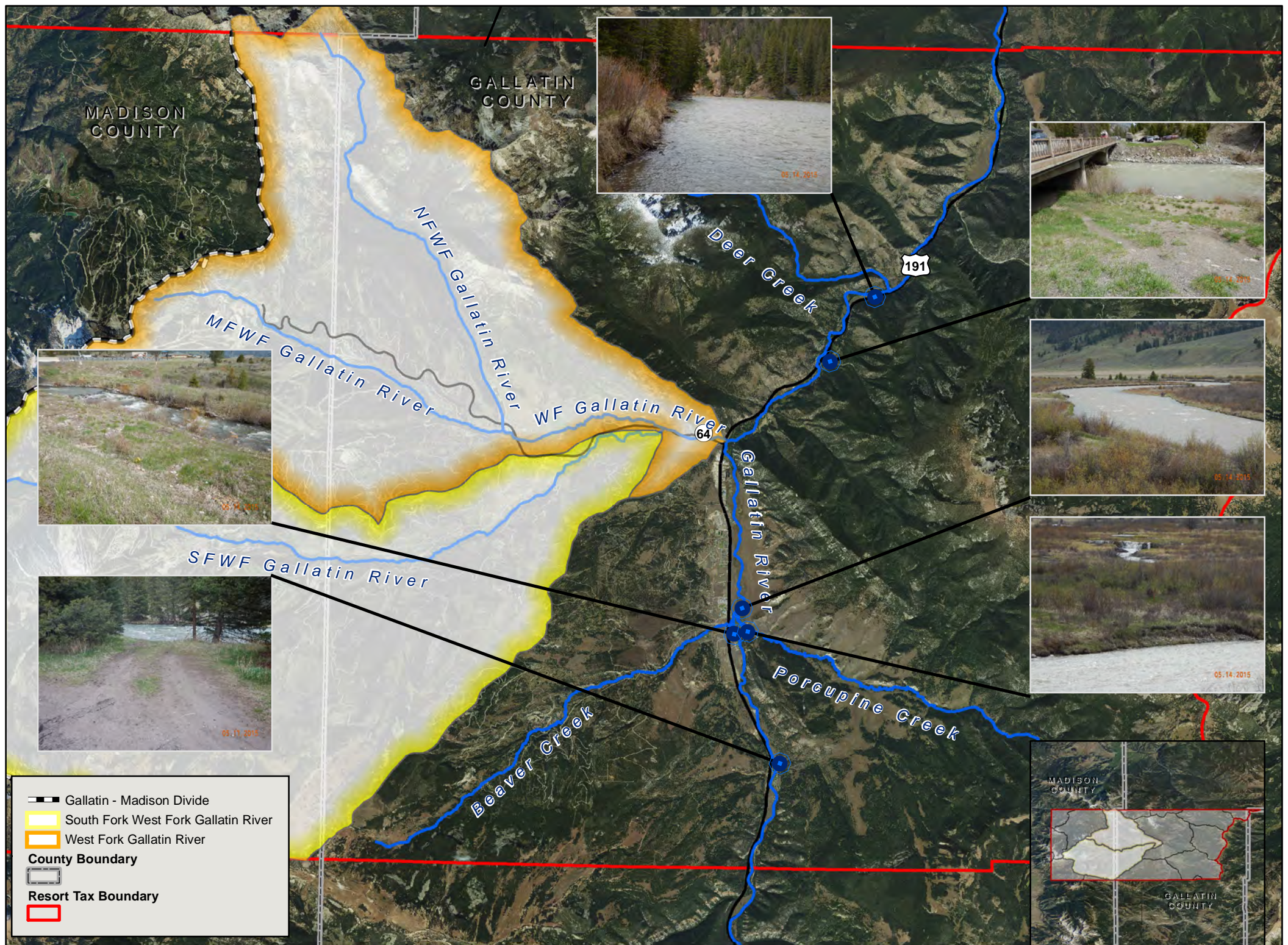
71 responses

Respondents were asked to identify ideas for solutions for water resources. Ideas varied greatly, ranging from water conservation, improvements to water quality, riparian and wetland areas, existing and new wastewater reuse options (irrigation, snowmaking), changes or centralization to infrastructure mix in Lower Basin (“Canyon”) area, wastewater treatment levels, planning and changes for institutional and organizational leadership, new regulations, mechanisms for limiting growth, protecting economic development, improved knowledge and practices related to water, and greater accountability. 71 people responded, but some responses had multiple topics, so those were counted and reflected here.

Ideas to Improve Water Resources	
Area Identified	Ideas and Suggestions
Ecological Health of River Systems	10
Water Supply and Availability	25
Wastewater Treatment and Reuse	19
Drought/Climate Change	1
Organizational/Institutional Issues	9
Education, Outreach, and Public Relations	4
Economics and Growth	10
Accountability and Transparency	7
Other	0

Appendix F

Big Sky Area Subwatershed Maps



MADISON COUNTY

GALLATIN COUNTY

NFWF Gallatin River

MFWF Gallatin River

WF Gallatin River

SFWF Gallatin River

Deer Creek





Gallatin River

Beaver Creek

Porcupine Creek

191

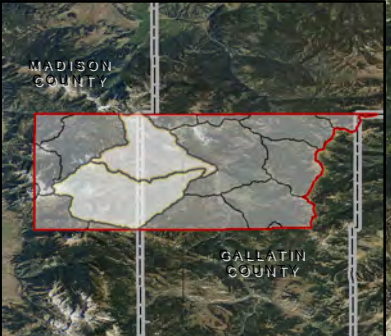
64

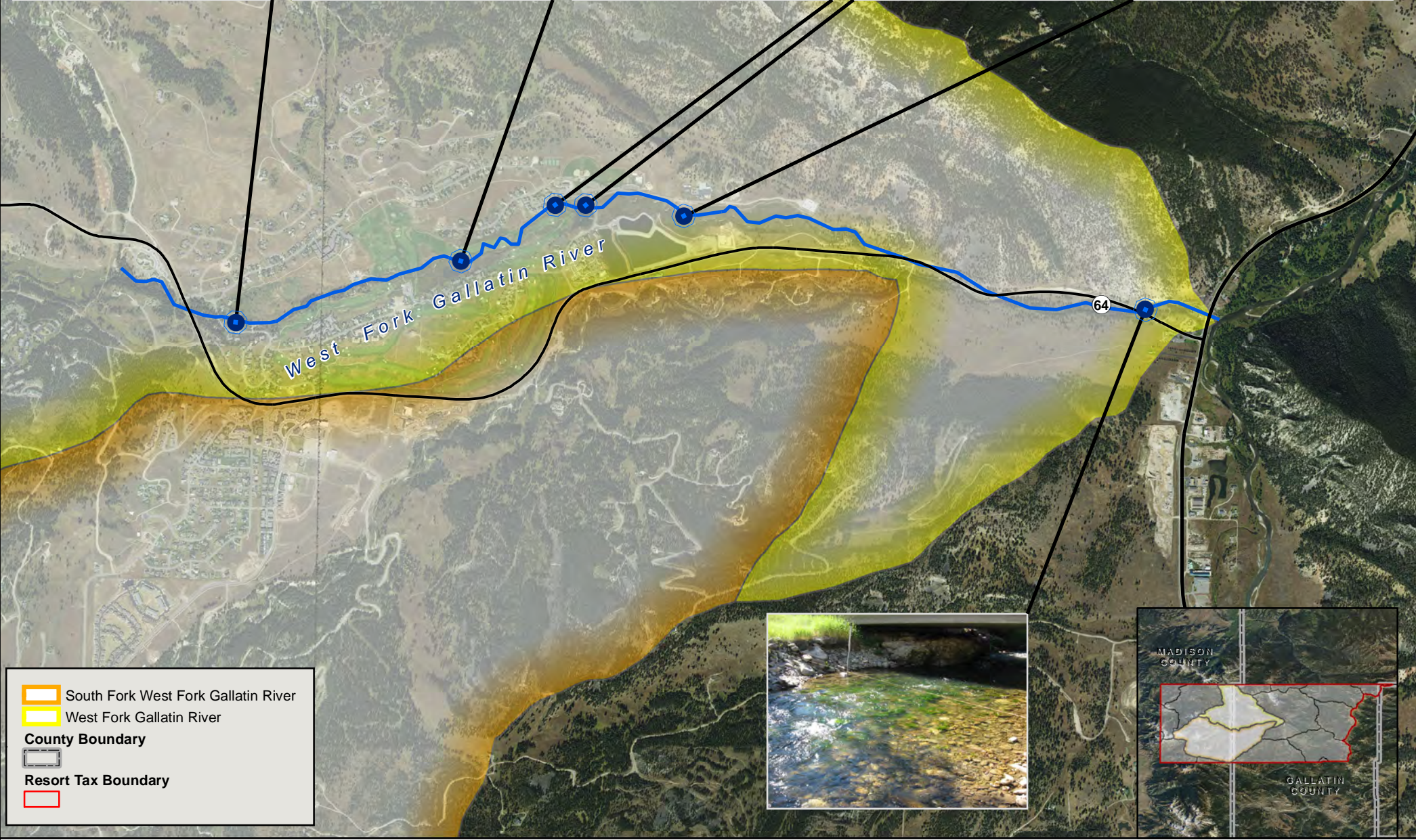
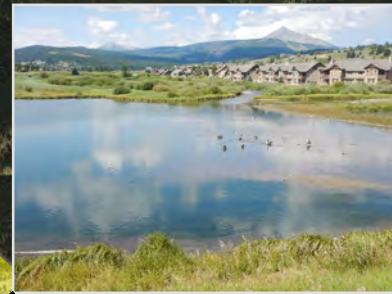
-  Gallatin - Madison Divide
-  South Fork West Fork Gallatin River
-  West Fork Gallatin River
- County Boundary**
-  Resort Tax Boundary

Gallatin River Mainstem



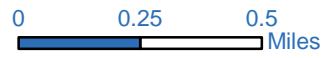
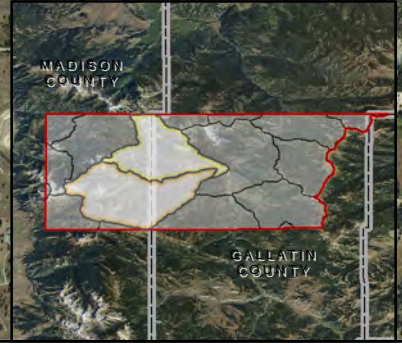
0 0.75 1.5 Miles

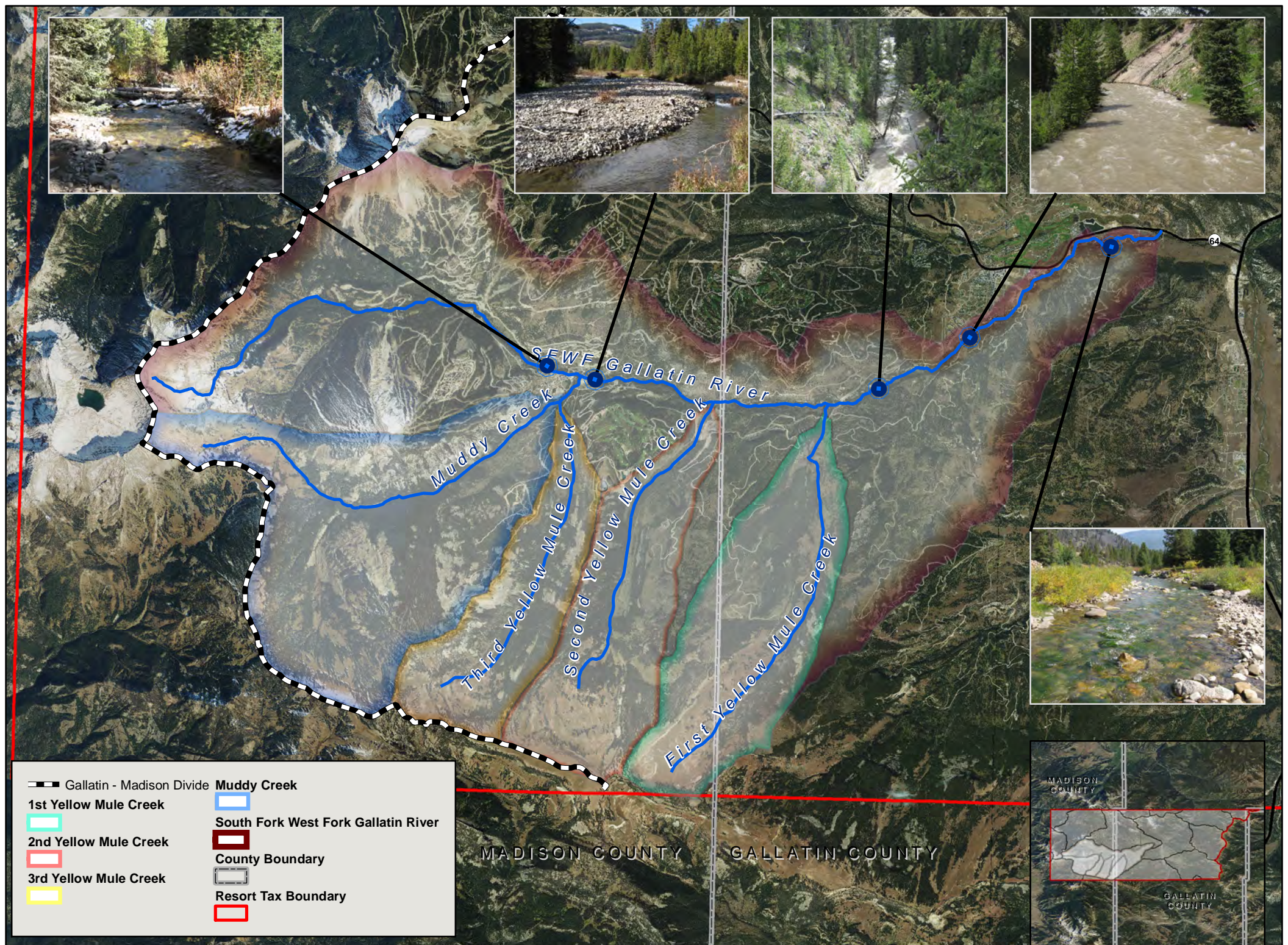




South Fork West Fork Gallatin River
 West Fork Gallatin River
County Boundary

Resort Tax Boundary





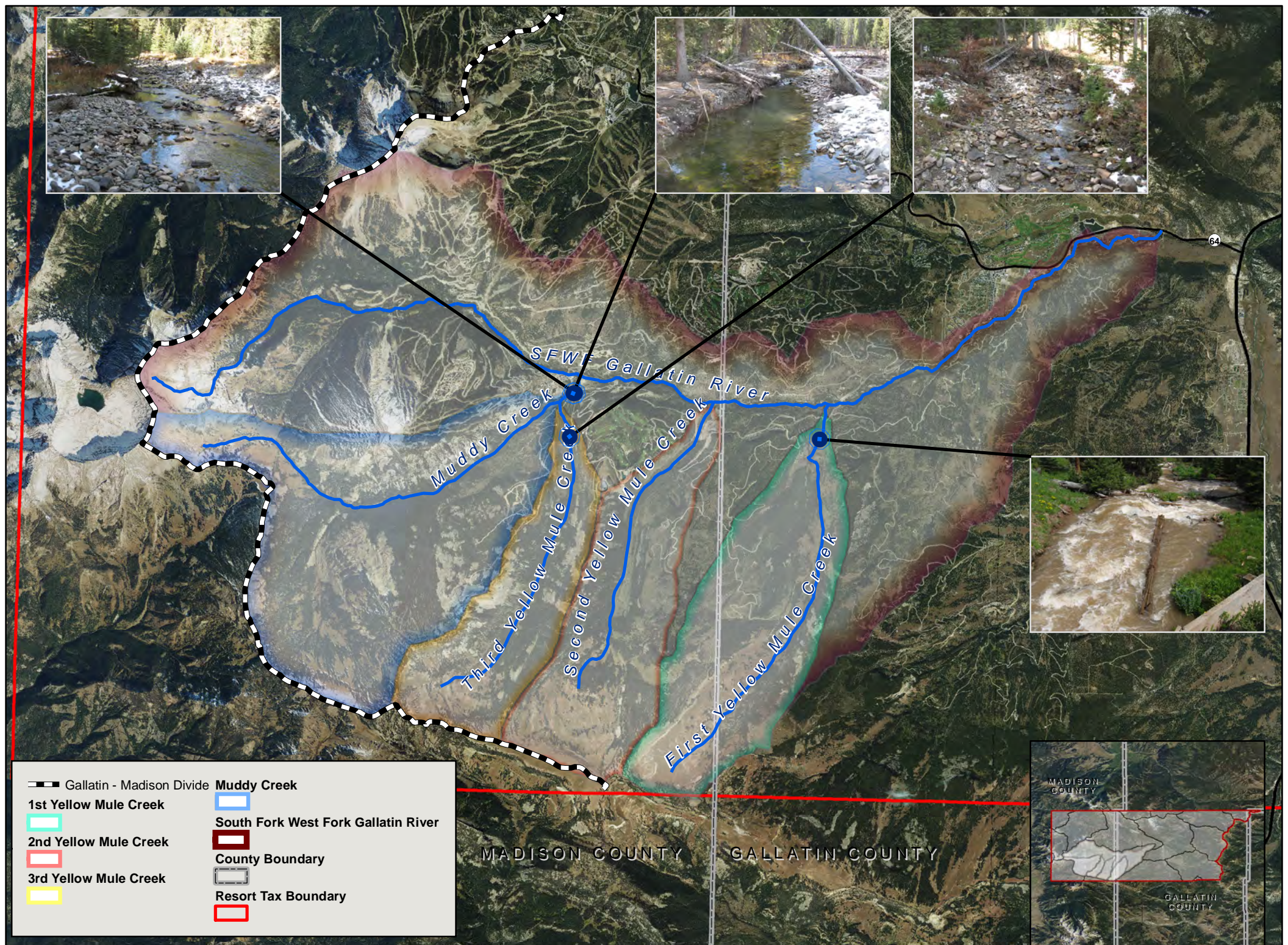
- | | |
|---------------------------|-------------------------------------|
| Gallatin - Madison Divide | Muddy Creek |
| 1st Yellow Mule Creek | South Fork West Fork Gallatin River |
| 2nd Yellow Mule Creek | County Boundary |
| 3rd Yellow Mule Creek | Resort Tax Boundary |
| | |

MADISON COUNTY

GALLATIN COUNTY

South Fork West Fork Gallatin River





Gallatin - Madison Divide	Muddy Creek
1st Yellow Mule Creek	South Fork West Fork Gallatin River
2nd Yellow Mule Creek	County Boundary
3rd Yellow Mule Creek	Resort Tax Boundary







South Fork West Fork Gallatin River Tributaries



MADISON COUNTY

GALLATIN COUNTY



-  Gallatin - Madison Divide
-  Beehive Creek
-  North Fork West Fork Gallatin River
-  Middle Fork West Fork Gallatin River
-  County Boundary
-  Resort Tax Boundary

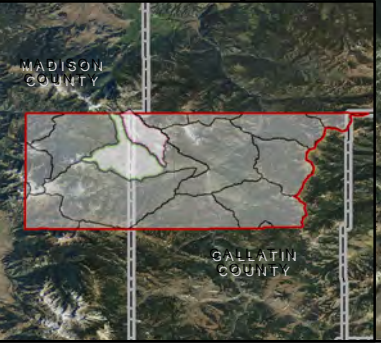
Beehive Creek

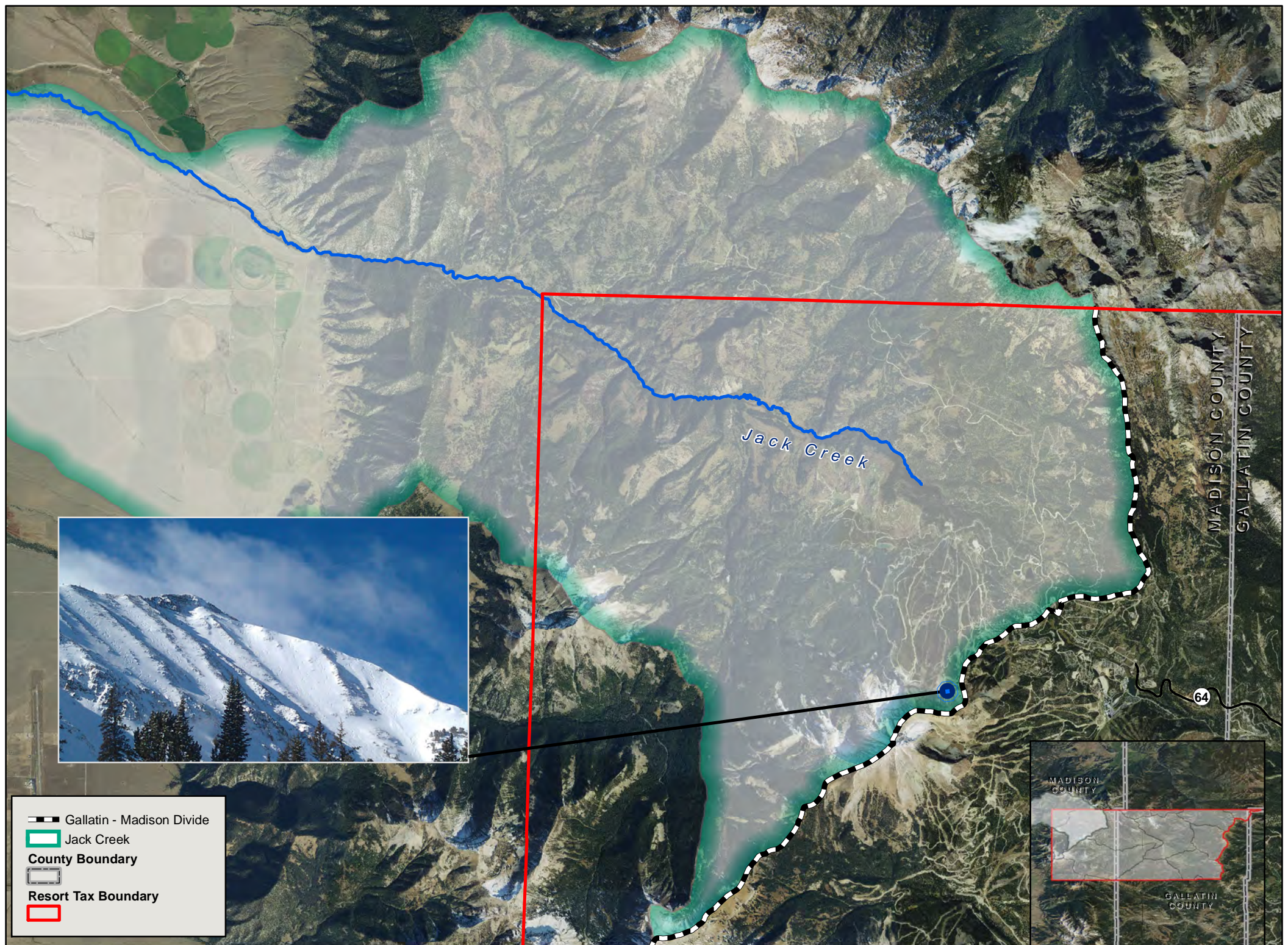
NFWF Gallatin River






MFWF Gallatin River

64

64





-  Gallatin - Madison Divide
-  Jack Creek
-  County Boundary
-  Resort Tax Boundary
-  Resort Tax Boundary



Jack Creek



Appendix G

Potential Environmental Indicators for Water Supply and Availability and Wastewater Treatment and Reuse

Potential Environmental Indicators for Water Supply and Availability

Index	Environmental Indicator	Monitoring Parameter
Groundwater and Surface Water	Groundwater Quantity	Number of Wells
		Capacity of Wells
		Well Water Levels
		Ground Water Rights
	Groundwater Quality	Nitrate Concentrations
	Surface Water Quantity	Annual Water Yield
		Baseflows
		Surface Water Rights
	Surface Water Quality	Total Nitrogen
Nitrate + Nitrite		
<i>E. coli</i>		
Water Use and Climate Variability	Household Water Use	Number of SFEs
		Gallons per Day
	Irrigation Water Use	Million Gallons per Year
		Acres of Lawn/Grass
	Precipitation	Annual Precipitation

Potential Environmental Indicators for Wastewater Treatment and Reuse

Index	Environmental Indicator	Monitoring Parameter
Centralized Wastewater Treatment	Treated Wastewater Quality	Total Nitrogen
		Ammonia
		Total Phosphorus
		BOD
		TSS
		<i>E. coli/coliform</i>
		Priority Pollutants
		Whole Effluent Toxicity
	Treated Wastewater Volume	Million Gallons per Year
		Reservoir Storage Capacity compared to Commitments
		Population Served
Treated Wastewater Reuse	Land Application / Nutrient Loading Database	
	Transmissivity	
	Evapotranspiration	
On-site Septic Systems	Ground Water Quality	Nitrate Concentrations
		Number of Septic Systems
		Septic Condition

Appendix H

West Fork Gallatin River Streamflow and Water Yield Analysis

TECHNICAL MEMORANDUM

To: Kristin Gardner
Executive Director
Gallatin River Task Force
PO Box 160513
Big Sky, MT 59716

From: Troy Benn, PhD, PE, CFM
Water Resources Engineer
RESPEC
3810 Valley Commons Drive, #4
Bozeman, MT 59718

Jeff Dunn
Watershed Hydrologist
RESPEC
3810 Valley Commons Drive, #4
Bozeman, MT 59718

Date: January 17, 2018

Subject: West Fork Gallatin River Streamflow and Water Yield Analysis

INTRODUCTION

An analysis of streamflow data within the West Fork Gallatin River watershed was conducted to determine annual water yields and evaluate the potential impacts of increasing amounts of impervious areas due to expanding development. Mean daily streamflows for the West Fork Gallatin River watershed were derived from streamflow data collected by the Gallatin River Task Force (GRTF). This data was used to develop mean monthly streamflows for the April through November timeframe, which were compared to Montana Fish, Wildlife and Parks (FWP's) instream flow reservations. In addition, the Thornthwaite model was used to develop annual water yields and evaluate changes in streamflow due to increased impervious areas.

METHODS

Stream Gage Data

Stream gage data has been collected by GRTF at four sites on the West Fork Gallatin River since 2006. **Figure 1** shows the gage locations on the upper West Fork Gallatin River, lower West Fork Gallatin River, South Fork West Fork Gallatin River and North Fork West Fork Gallatin River. Continuous stage data has been collected using sonic ranging sensors and data loggers since 2009 and data from 11/11/2009 through the present is stored as "water depth" on Montana State University's VOEIS Data Hub (<https://voeis.msu.montana.edu>). Periodic streamflow measurements conducted by GRTF using current meters and velocity-area principles were used to develop stage-discharge relationships (i.e. rating curves) for the 2010-2016 timeframe, while additional streamflow data from 2006-2009 previously analyzed was also included in this assessment.

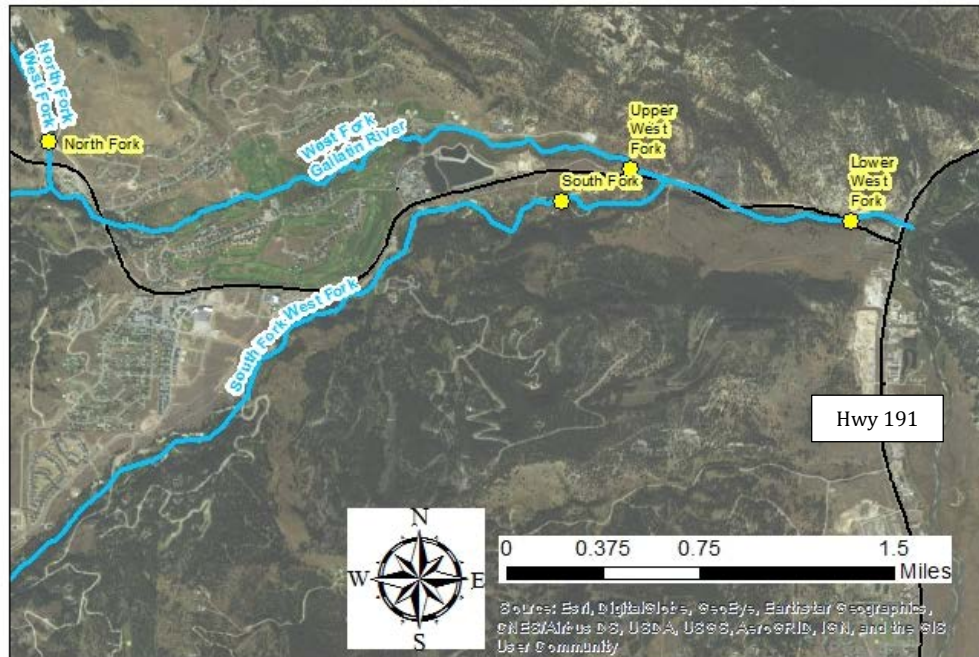


Figure 1. West Fork Gallatin River Watershed Streamflow Gaging Locations

Thornthwaite Model – Water Yield

The Thornthwaite model estimates monthly basin runoff volume based on temperature and precipitation data and a mass balance calculation. Temperature and precipitation data for the West Fork Gallatin River watershed were obtained from the Natural Resource Conservation Service Lone Mountain SNOTEL site between 1992 and 2017. Precipitation and temperature were assumed equal across the basin to simplify the mass balance calculation. Thornthwaite model parameters were calibrated based on mean monthly flow data from 2008 for the lower West Fork Gallatin River streamflow gage, which is located just upstream of the confluence with the Gallatin River mainstem. The Thornthwaite model output is runoff in depth units of millimeters. Model output was multiplied by the basin area to obtain a runoff volume, which was then converted to a mean monthly flow rate. Basin area above the lower West Fork Gallatin River streamflow gage was determined as 80 square miles using USGS StreamStats (<https://ssdev.cr.usgs.gov/streamstats/>). **Table 1** shows the input parameters used to calibrate the Thornthwaite model.

Table 1. Thornthwaite Model Parameters Calibrated to 2008 Stream Gage Data

<i>Parameter</i>	<i>Value</i>
Runoff Factor (%)	74
Direct Runoff Factor (%)	3
Soil-Moisture-Storage Capacity (mm)	150
Latitude (degrees)	45
Rain Temperature (°C)	1.2
Snow Temperature (°C)	-1
Maximum Melt Rate (%)	65

Stream gage data for the lower West Fork Gallatin River site was converted from mean daily flow to mean monthly flow to compare with Thornthwaite model output. The 2006-2016 streamflow gage data is generally valid for summertime flows post-runoff due to the calibrated range of the stage-discharge curves. However, in 2008, an adequate rating curve was developed to capture the full runoff hydrograph, including high flow conditions (Dunn 2009). Therefore, the 2008 gage data were used to calibrate the Thornthwaite Model. The adequacy of calibration is judged on 1) matching the 2008 runoff hydrograph and 2) matching the post-runoff hydrograph for all years of gage data.

RESULTS AND DISCUSSION

Stream Gage Data

Stream gage data from four measurement locations in the West Fork Gallatin River Watershed were transformed to flow estimates using rating curves. Where data were missing at the lower West Fork Gallatin River gage, flows from the South Fork West Fork Gallatin River and upper West Fork Gallatin River gages were summed as an estimate of flow at the lower West Fork Gallatin River gage. Daily mean flows at the lower West Fork Gallatin River gage for 2006-2016 are shown in **Figure 2**. Anchor ice and snow accumulation are known to interfere with stage measurement instrumentation, and data is only valid during ice free conditions from mid-April to mid-November. For the winter months, baseflow was estimated as 19 cubic feet per second based on an average of the last valid flow estimate of each year.

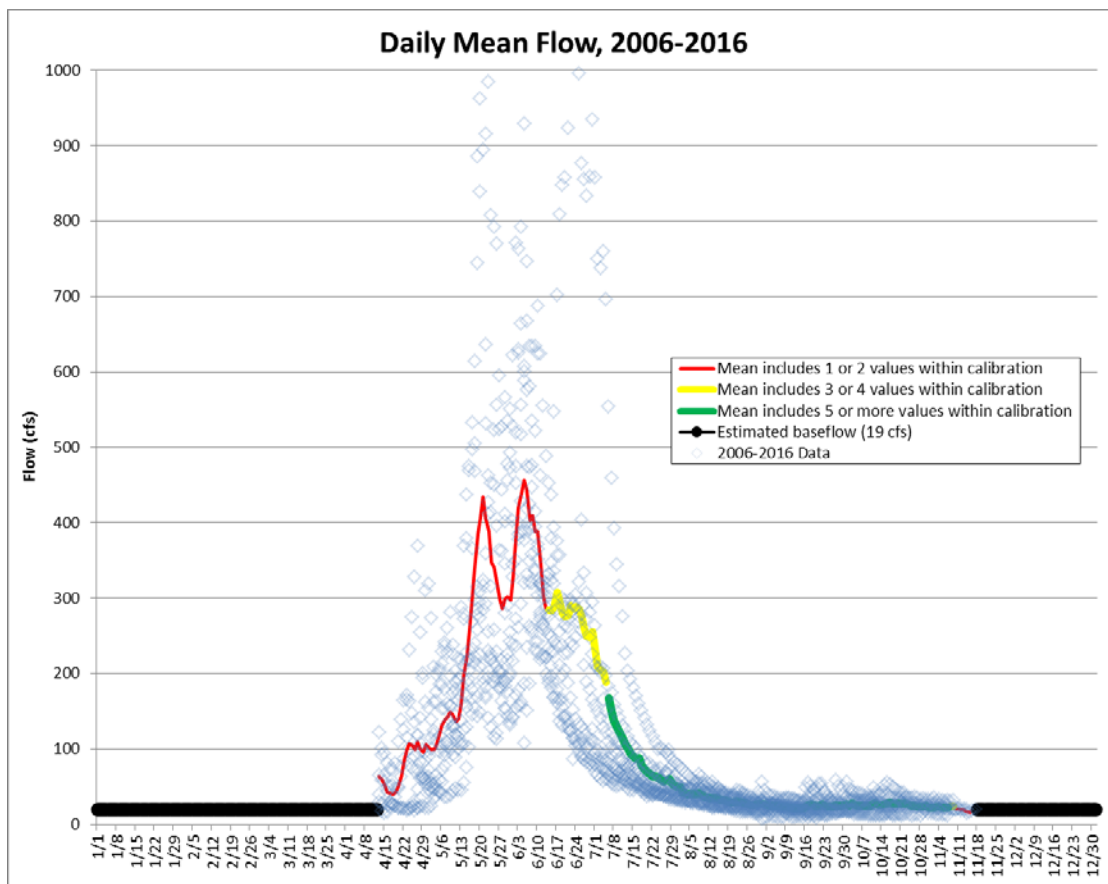


Figure 2. Daily Mean Streamflows at the Lower West Fork Gallatin River Gage, 2006-2016

The red line of **Figure 2** represents the average daily mean streamflow for the rising limb and peak runoff and much of this data is derived from flow estimates outside of the rating curve calibration. Therefore, low confidence is associated with the accuracy of rising limb and peaks of the hydrograph. The yellow line represents the average daily mean which was calculated with at least 3 or 4 values from within the rating curve. Therefore, more confidence is associated with the yellow line than the red. The highest confidence is associated with the green line, which is the average mean daily flow from July through October. This average was derived from 5 or more values from within the rating curve calibration. Tabular mean daily flow values are provided in **Table 2**.

Table 2. Daily Mean Streamflows at the Lower West Fork Gallatin River Gage, 2006-2016

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	19	19	19	19	71	329	233	49	27	26	23	19
2	19	19	19	19	74	378	209	43	25	25	22	19
3	19	19	19	19	84	419	204	41	24	28	23	19
4	19	19	19	19	97	439	202	41	25	25	23	19
5	19	19	19	19	110	456	189	40	25	25	22	19
6	19	19	19	19	120	444	167	41	24	25	22	19
7	19	19	19	19	124	403	150	40	23	25	22	19
8	19	19	19	19	130	409	137	41	23	25	24	19
9	19	19	19	19	142	388	128	39	23	25	24	19
10	19	19	19	19	141	388	121	37	23	25	20	19
11	19	19	19	19	130	343	115	36	22	28	20	19
12	19	19	19	19	128	302	107	34	22	26	19	19
13	19	19	19	64	142	286	100	35	21	25	19	19
14	19	19	19	59	172	284	93	35	22	26	17	19
15	19	19	19	52	193	283	91	34	21	27	16	19
16	19	19	19	43	227	288	86	33	24	28	19	19
17	19	19	19	41	265	308	87	32	25	29	19	19
18	19	19	19	41	300	295	78	31	26	27	19	19
19	19	19	19	43	313	280	74	30	26	26	19	19
20	19	19	19	50	328	276	69	29	23	28	19	19
21	19	19	19	64	344	276	67	30	24	27	19	19
22	19	19	19	84	334	290	63	30	27	28	19	19
23	19	19	19	98	303	286	63	30	24	27	19	19
24	19	19	19	107	282	289	62	29	23	25	19	19
25	19	19	19	105	278	285	59	27	24	25	19	19
26	19	19	19	99	260	276	56	27	23	24	19	19
27	19	19	19	109	256	259	58	26	26	24	19	19
28	19	19	19	100	263	249	60	25	25	23	19	19
29	19	19	19	96	292	248	55	26	24	24	19	19
30	19		19	106	303	255	52	26	25	24	19	19
31	19		19		303		50	27		23		19

Red = Mean calculated from less than 3 data points
 Yellow = Mean calculated from 3 or 4 data points
 Green = Mean calculated from 5 or more data points
 No shading = Estimated baseflow of 19 cfs

Mean daily streamflows for the lower West Fork Gallatin River were compiled into mean monthly flows to visualize monthly averages throughout the summer season. **Figure 3** shows average mean monthly flows for April-November based on data collected between 2006-2016. Error bars provide insight into data confidence by showing one standard deviation from the mean. The error bars are greater for April, May, and June compared to July through November, which is explained by two factors. First, variability in timing and quantity of peak flows will cause larger standard deviations in runoff during May and June. Second, flow measurements during the rising limb and peaks of the hydrograph can be difficult to obtain, and therefore April-June data is plagued with values outside of rating curve calibration.

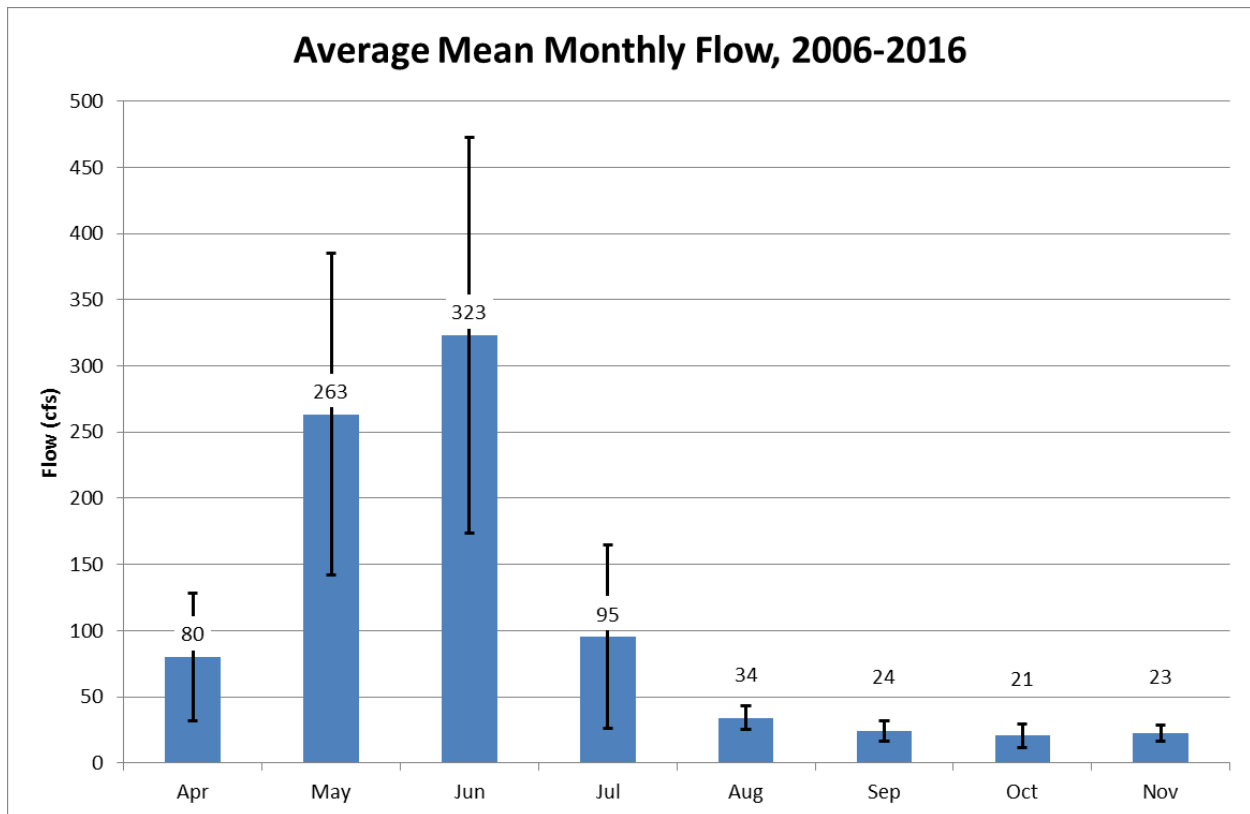


Figure 3. Average Mean Monthly Streamflows for the West Fork Gallatin River, 2006-2016

Stream Gage Data – Comparison with Instream Flow Reservations

Another way to assess the occurrence of low flows on the West Fork Gallatin River is to compare gage data with instream flow reservations held by FWP, which owns a water right (41H 30008931) to protect 26 cfs year-round in the West Fork Gallatin River from the mouth upstream to the confluence of the Middle West Fork Gallatin River and North Fork West Fork Gallatin River. FWP instream flow reservations on the West Fork Gallatin River are often not met during late summer. **Figure 4** shows the West Fork drops below FWP’s 26 cfs instream flow for an average of 37 days during the timeframe for which streamflows were evaluated, generally between April and mid-November. Therefore, the West Fork watershed is vulnerable to seasonal instream water shortages.

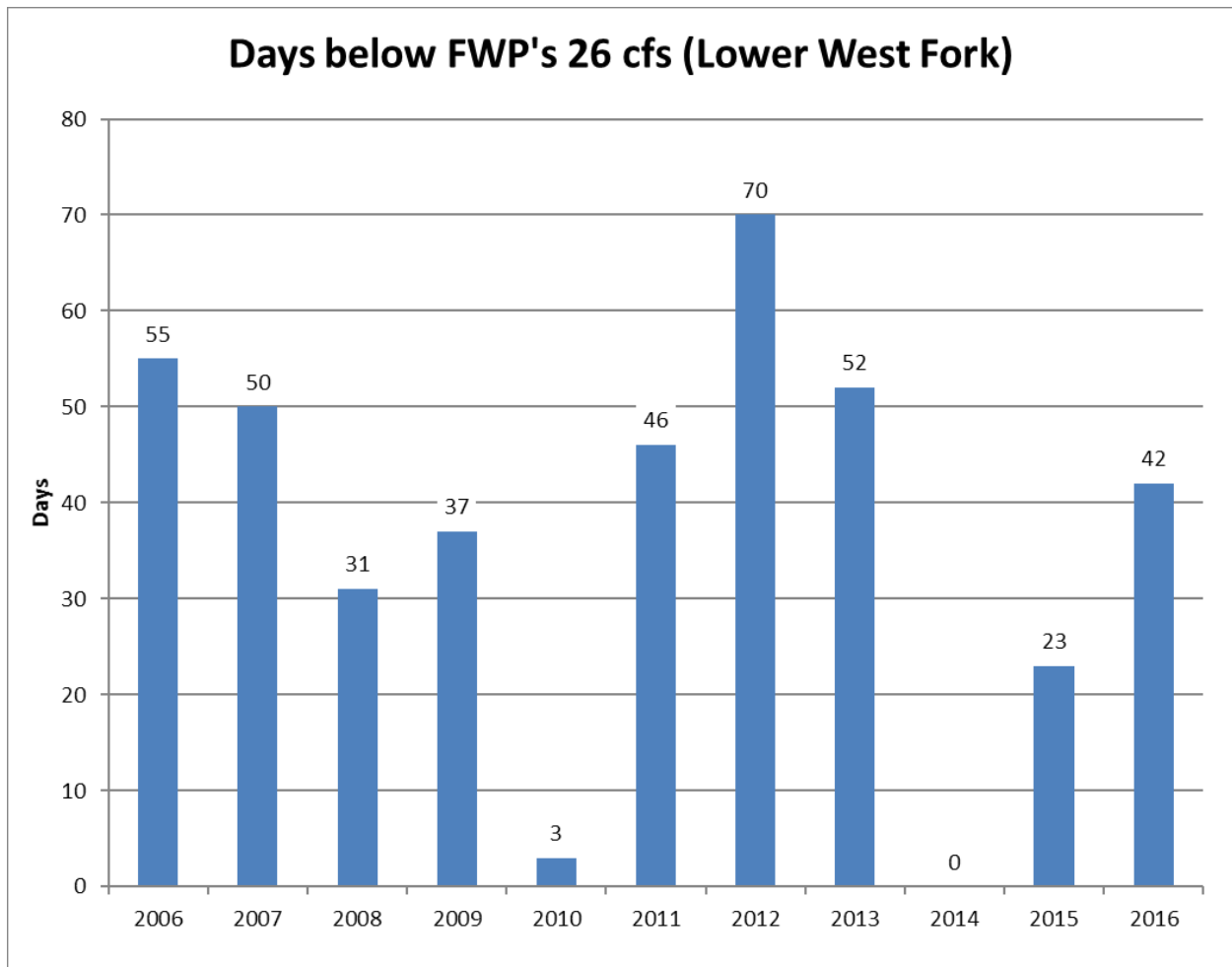


Figure 4. Number of Days with Streamflows below FWP's Instream Flow Reservation of 26 cfs

Thornthwaite Model – Water Yield

Since existing streamflow measurements are only validated over the July through October timeframe, the Thornthwaite model was used to provide estimates of annual water yield generated within the West Fork Gallatin River watershed. The water yield estimates provided by the Thornthwaite model were then used to develop a water balance examining changes in the amount of impervious surface areas within the watershed due to expanding development. The Thornthwaite model was calibrated with 2008 data for which the widest-ranging rating curve was developed. Model results were then expanded to estimate mean monthly flows for the 2006-2016 timeframe using precipitation and temperature data from the Lone Mountain SNOTEL site (**Figure 5**). The model results adequately represent peak flows in years where peak flow gage measurements are missing. For example, the model estimates 2011 peak runoff as the highest which is known to be the highest runoff year of 2006-2016. Similarly, 2015 was known to be a low runoff year, which is accurately reflected in the model results.

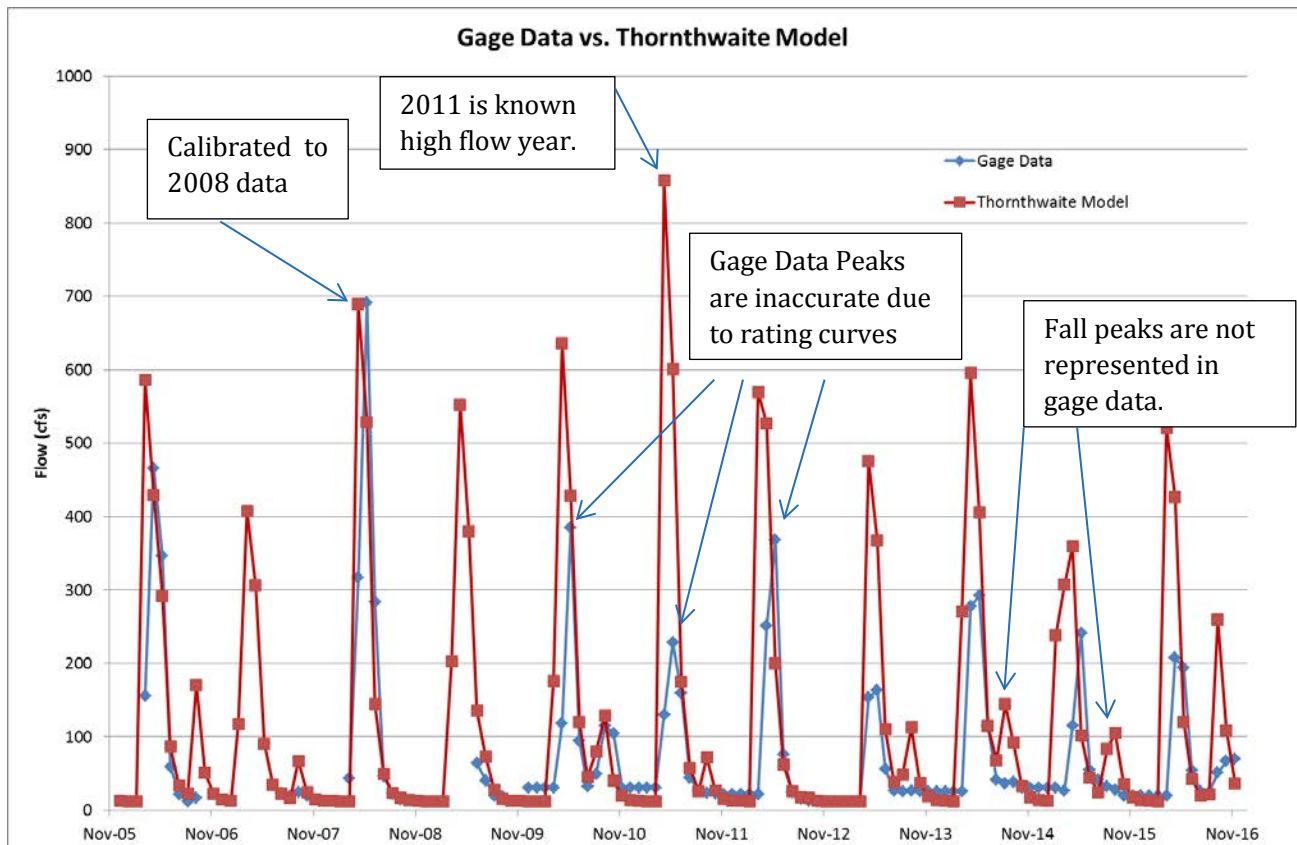


Figure 5. Comparison of Lower West Fork Gallatin River Stream Gage Data with Thornthwaite Model Results

Precipitation is the main water input to the Big Sky area headwater system. Average annual precipitation (1992-2016) at the Lone Mountain SNOTEL station is 33.54 inches. The West Fork Gallatin watershed is 51,200 acres yielding an average annual precipitation volume of 143,100 acre feet (46,629 million gallons). However, not all precipitation contributes to streamflow; water is lost to evaporation and transpiration by plants. The Thornthwaite model estimates an average annual volume of 92,890 acre feet (30,268 million gallons) in the West Fork Gallatin River (**Table 3**). Thus, approximately one third of annual precipitation does not manifest as streamflow in the West Fork Gallatin River. In comparison, the Gallatin River at Gallatin Gateway has average annual water yield of 584,490 acre feet (190,457 million gallons). Thus, the West Fork Gallatin River contributes approximately 15% of the flow to the Gallatin River mainstem. In addition, FWP's instream flow reservation (41H 30008931) on the West Fork Gallatin River is year-round for 26 cfs. For July-October, the reservation is for 6,190 acre feet which is 34% of the average summertime runoff volume. Similarly, FWP's annual reservation of 18,822 acre feet is 20% of the modeled average annual volume derived from the West Fork Gallatin River watershed.

Table 3. Modeled West Fork Gallatin River Water Annual Water Yield, 2006-2016

	<i>Peak Mean Monthly Runoff Flow (cfs)</i>	<i>July - October Volume (AF)</i>	<i>Annual Volume (AF)</i>
2006	586	19,183	104,371
2007	408	8,529	68,179
2008	689	14,376	92,712
2009	552	15,460	87,786
2010	636	22,848	103,661
2011	858	20,201	114,208
2012	569	18,311	89,286
2013	476	18,946	76,210
2014	595	25,493	107,570
2015	360	15,653	81,376
2016	521	21,083	96,428
AVE	568	18,189	92,890

Thornthwaite Model – Impervious Surface Evaluation

Development in the Big Sky area will lead to an increased percentage of impervious surfaces and the Thornthwaite model was used to evaluate the effect of increasing impervious area on annual water yield. **Figure 6** compares the calibrated Thornthwaite model, which depicts the existing conditions within the West Fork Gallatin River watershed, to a high-impervious scenario. For the high-impervious scenario, the Direct Runoff Factor in the Thornthwaite model was increased from 3% to 50%. Two general trends result. First, late summer/fall precipitation events lead to spikes in streamflow. This is due to a higher fraction of the precipitation running directly into the stream channel rather than being taken up by vegetation or absorbed into the groundwater system. Second, late fall/winter flows are diminished because fall precipitation “flashes” off and is not stored in groundwater, which is the source baseflow throughout the winter. **Figure 7** shows these trends in more detail for 2011 data. The high-impervious scenario leads to higher flows in August, September, and October for rain events. Conversely, the high impervious scenario results in lower flows in November, December, and January. The increase in flows during August, September, and October during rain events may be a benefit of increases in impervious surface area. However, the drawbacks of lower flows in November, December, and January may outweigh these benefits.

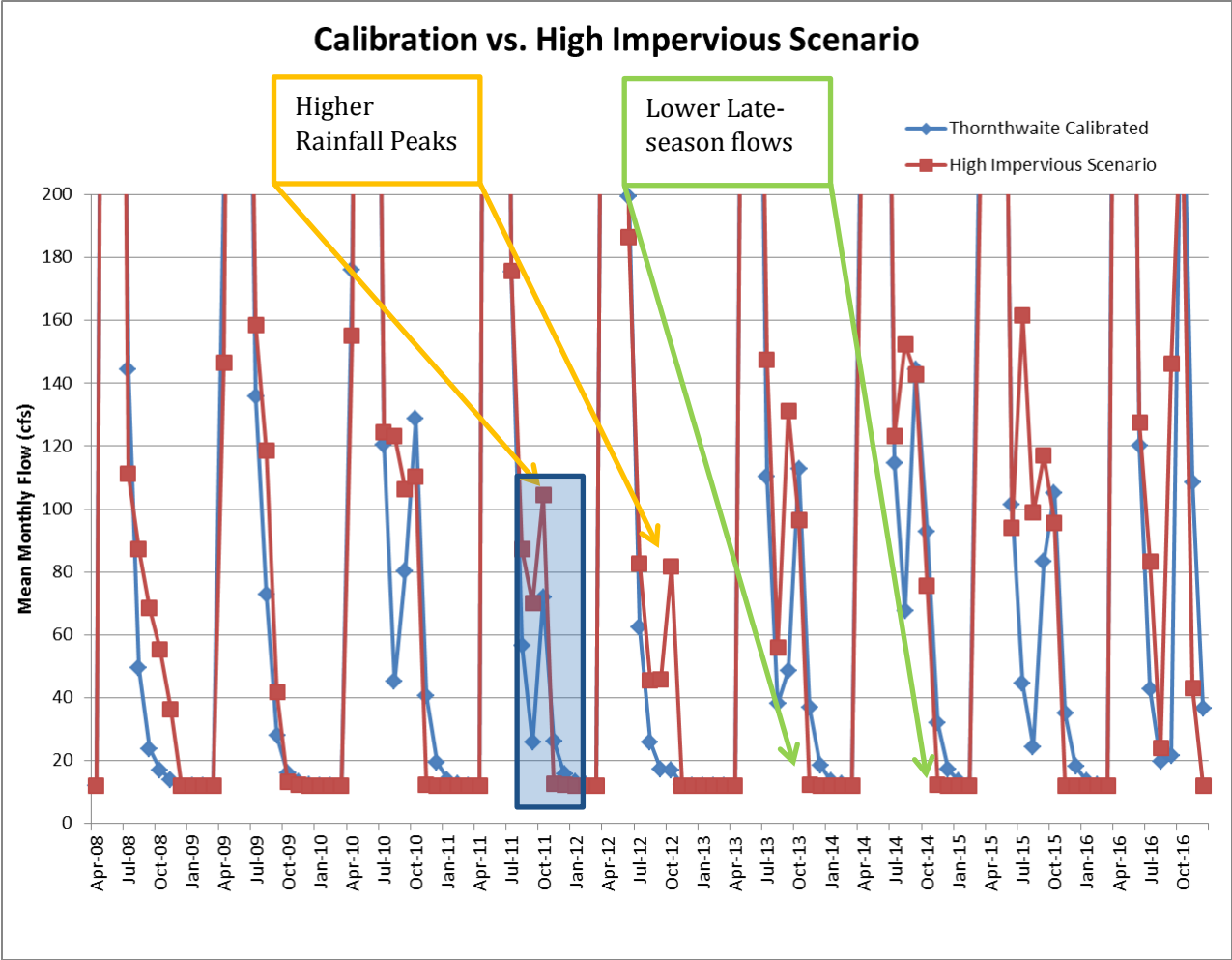


Figure 6. Existing Conditions based on Thornthwaite Calibrated Model Compared to High-Impervious Scenario, 2008-2016

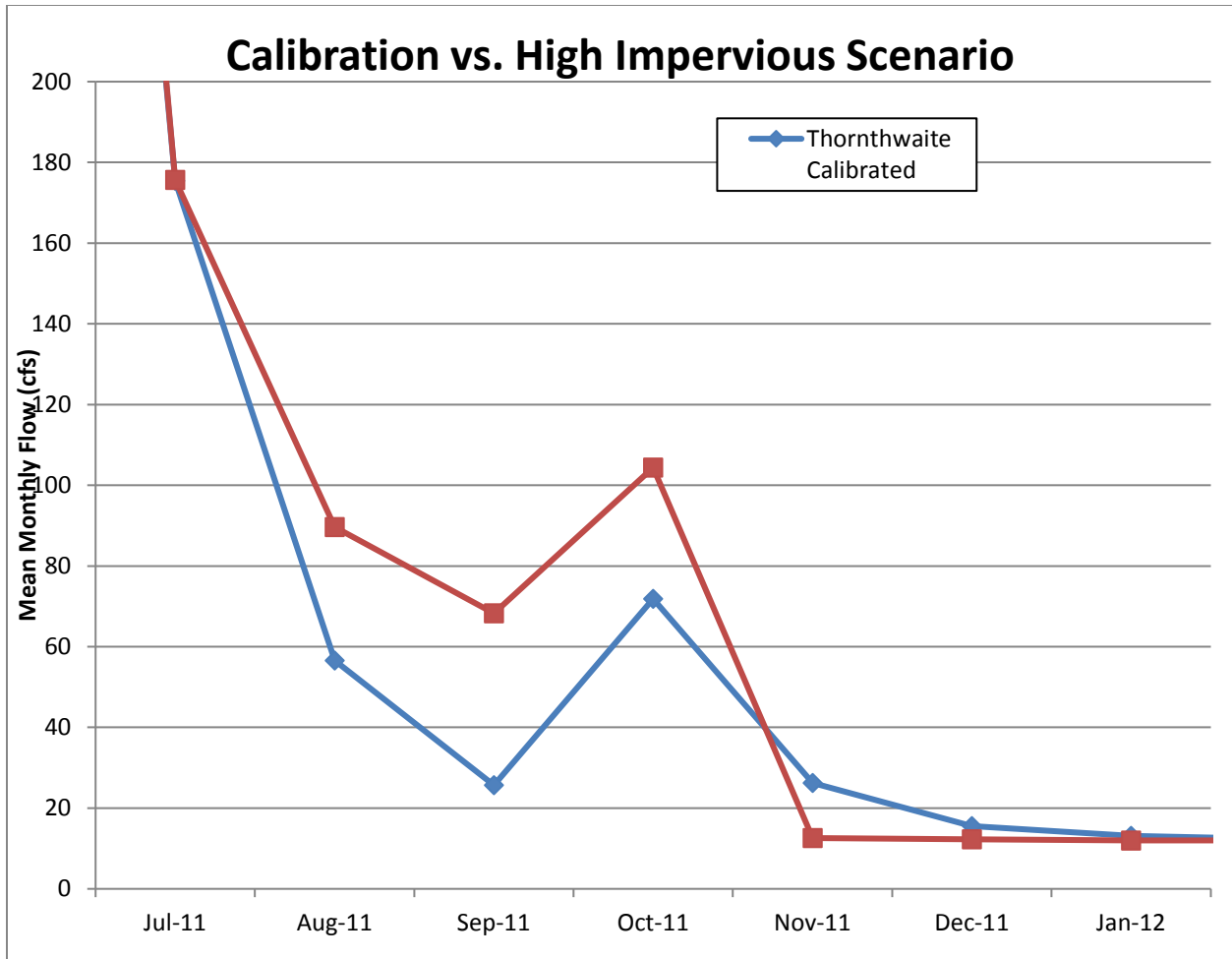


Figure 7. Existing Conditions based on Thornthwaite Calibrated Model Compared to High-Impervious Scenario, July 2011-January 2012 (excerpt of blue box in Figure 6)

REFERENCES

Dunn, J., 2009, West Fork Gallatin River Streamflow Study 2007-2008, Upper Gallatin TMDL Planning Area, Prepared for the Blue Water Task Force and Montana Department of Environmental Quality

McGage, G.J., and Markstrom, S.L., 2007, A monthly water-balance model driven by a graphical user interface: U.S. Geological Survey Open-File report 2007-1088, 6p.

Appendix I

Unanswered Questions Regarding Direct Surface Water Discharge

What is the Ecological Impact of Direct Discharge?

1. Can direct discharge have a positive impact on the ecological health of the river systems?
2. Can wastewater be treated to a level that ensures no negative impact to the ecological health of the river systems and what is the necessary treatment level?
3. What monitoring is needed to ensure there are no negative impacts to the ecological health of the river systems?
4. Where will direct discharge occur? Gallatin River, West Fork Gallatin River or other streams? Where will it be most beneficial to the ecological health of the river systems?
5. When will direct discharge occur? Winter, spring, summer or fall? When will it be most beneficial to the ecological health of the river systems?
6. Can direct discharge be timed to minimize impacts to the ecological health of the river systems?
7. What will the quantity of direct discharge be and what will be the impact to streamflows?
8. What will the quality of direct discharge be and what will be the impact to water quality?
9. Can direct discharge be conducted in a way that meets requirements for non-degradation and Montana's nutrient standards?
10. Is there a way to avoid or ameliorate potential negative impacts of the mixing zone on water quality, fish movement and habitat?
11. At what point does wastewater turn from a liability into an asset?
12. How does direct discharge compare to irrigation, snowmaking and shallow groundwater recharge in terms of "slowing the flow" of water through the system?
13. Is the ecology of the Gallatin River significantly different from that of other rivers in southwest Montana into which direct discharge is occurring?

What is the Economic Impact of Direct Discharge?

1. Can direct discharge have a positive impact on local businesses?
2. What is the impact of direct discharge on river recreation, guided fishing and rafting?
3. What is the impact of direct discharge on downstream water rights holders and agricultural producers?

4. What are the impacts to future development and housing affordability?
5. What is the impact to the operations and management of BSCWSD and other wastewater treatment plants?
6. What is the cost for technology to treat to a level needed to ensure no negative ecological impact to the river systems?
7. What is the cost-benefit analysis for direct discharge compared to other alternatives and including environmental costs? How are costs borne equitably?
8. How does direct discharge impact the ecological health of the river systems given the cumulative effects of ongoing development and increasing recreational pressures?
9. Is direct discharge acceptable during times when wastewater treatment plant operators need to perform maintenance activities (i.e. replace pond liners), during an emergency (i.e. if ponds leak or if pumps fail), or if there is an exceptionally wet year and irrigation can't be used to the extent planned?
10. What are the risks of this alternative compared to other reuse alternatives?

What is the Social Impact of Direct Discharge?

1. Can direct discharge have a positive impact on community health?
2. Do community support levels change if direct discharge can be shown to positively impact the ecological health of the river systems?
3. Can direct discharge be conducted in a way that is supported by the community?
4. If direct discharge is determined to be the most inexpensive alternative, does that make it more acceptable to the community?
5. Are the costs of building and running a state of the art wastewater treatment system that has demonstrated no negative impact to the ecological health of the river systems something community members are willing to pay for?
6. Does expanding BSCWSD to reduce the number of septic systems and small community systems justify a direct discharge?

Appendix J

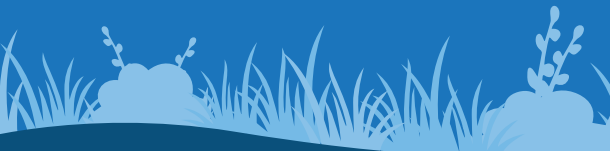
Big Sky Sustainable Water Solutions Forum Infographics



ECOLOGICAL HEALTH OF RIVER SYSTEMS

OUR RIVERS ARE THE CENTERPIECE OF THE BEAUTIFUL BIG SKY AREA. MANY SMALL IMPACTS FROM OUR ACTIVITIES CAN CAUSE HARM TO FISH AND WILDLIFE HABITAT AND MAINTAINING RIVER HEALTH IS THE RESPONSIBILITY OF ALL OF US.

HEALTHY RIPARIAN AREAS



PROVIDE FOOD & HABITAT FOR FISH AND WILDLIFE



FILTER SURFACE RUNOFF & SHALLOW GROUNDWATER



HOLD STREAM BANKS TOGETHER



PROVIDE SHADE, COOLING STREAMS



SLOW FLOOD FLOWS

HEALTHY WETLANDS



PROVIDE HABITAT FOR WILDLIFE



FILTER RUNOFF, PROVIDING CLEAN WATER FOR FISH



BUFFER FLOOD FLOWS AND SLOW THE FLOW OF WATER



CHANGING WATER AND TEMPERATURE FACTORS



PRECIPITATION

Local ecology is adapted to long winters, snowpack runoff in May/June and relies on ground water flowing into streams during late summer, fall, and winter.



DROUGHT

Limited precipitation affects stream flows, ground water recharge and vegetation. Drought can negatively impact fish, drinking water supply, and increase fires.



CLIMATE

Warmer temperatures reduce snowpack and make peak streamflows run earlier and late summer streamflows run lower and warmer. Increasing evaporation also means vegetation and soils may dry out faster.

POLLUTANTS THAT CAN AFFECT RIVER HEALTH



NUTRIENTS

Nutrients are essential for fish and other aquatic life. Excess nutrient concentrations can lead to excess algal growth and cause harm to fish. Montana water quality standards have been exceeded for on the West Fork, Middle Fork, and South Fork.



E COLI

Bacteria that can come from natural and human sources. This is an indicator of fecal bacterial contamination. Increasing levels of E. coli correlate to increased health risks from waterborne illness. Water quality standards have been exceeded on the Middle Fork.



SEDIMENT

Sediment input to streams naturally occurs, especially during spring run-off. Excess sediment can harm fish and other aquatic life and can come from roads, construction and activities that degrade or remove riparian and wetland areas. Montana water quality standards have been exceeded on the West Fork, Middle Fork, and South Fork.



PERSONAL CARE PRODUCTS

Medication and personal care products can get into water through wastewater and domestic animal waste and enter the water in very small quantities. No state water quality standards exist. Very limited monitoring for these products has occurred in Big Sky.

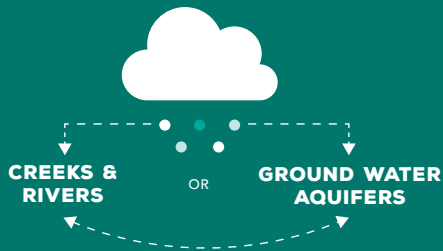


WATER SUPPLY AND AVAILABILITY

AS MORE PEOPLE DISCOVER THE JOY OF LIVING ALONG OUR BIG SKY AREA RIVERS AND STREAMS, INCREASING USE OF LIMITED WATER FOR HUMAN NEEDS MUST BE BALANCED WITH THE NEEDS OF FISHERIES AND AQUATIC LIFE.

PRECIPITATION

Rain and snow flows directly into rivers/ creeks or filters into ground water aquifers.



SURFACE WATER

Rivers, creeks, wetlands and other bodies of water

Snow melts and rain falls and runs across the land into surface water. Peak streamflows and some additional water come from runoff. In the rest of the year, streams flow because water comes up from ground water aquifers into streams.



GROUND WATER

Many different shallow and deep aquifers



Water from snow and rain filters through the ground into very complex geology that contains both shallow and deep aquifers. Aquifers also receive and deliver water to and from streams and are Big Sky's drinking water sources.



BIG SKY'S DRINKING WATER IS SUPPLIED BY

COMMUNITY WELLS

INDIVIDUAL WELLS

BIG SKY WATER AND SEWER DISTRICT PUBLIC WELLS



WATER USE IN THE SUMMER IS 7-8X HIGHER IN THE SUMMER BECAUSE OF LAWN AND LANDSCAPING IRRIGATION.



SNOWPACK

Good snow years = good runoff. Snowfall is the primary source of ground water and surface water in Big Sky.

VARIABLE WATER FACTORS



PRECIPITATION

The amount and timing of snow and rain drive water supply. At the top of the watershed, there is no upstream storage or water sources. Normally, snowpack stores water for much of the year and rainfall is heaviest in May and June, coinciding with peak runoff.



FISHERIES HAVE IN-STREAM FLOW RESERVATION, SPECIFYING NEEDED MINIMUM FLOWS.

WATER RIGHTS & REGULATION



Big Sky is entirely within a closed basin, which means that there are no new surface or connected ground water rights available. All our future water needs must be met with water rights that already have been claimed.



In Montana, water users must have a water right in order to use the water. People with older rights have priority for water use over those with younger, more junior rights. Big Sky's water rights are all junior to more senior rights downstream.

DROUGHT

Limited precipitation reduces water supply for drinking and in streams.



CLIMATE

Warmer temperatures reduce storage in snowpack, leading to earlier runoff and lower, warmer late summer stream flows. It also affects ground water recharge, but the relationship is complex.



WASTEWATER TREATMENT & REUSE

EVERYONE GENERATES WASTEWATER FROM THEIR HOUSEHOLD AND BUSINESS ACTIVITIES. BIG SKY WILL EVENTUALLY NEED NEW CAPACITY TO ENSURE THAT WASTEWATER WILL BE TREATED AND REUSED WISELY.

THE FLOW OF WASTEWATER IN BIG SKY WHEN USED WATER LEAVES YOUR HOME, IT TAKES ONE OF TWO PATHS DEPENDING ON YOUR LOCATION.



SEPTIC TREATMENT

Wastewater is separated from solids, and bacteria provide initial wastewater treatment. Concentrated waste (septage) must be pumped periodically. Septage is primarily land applied in the Gallatin Valley.



SEPTIC FIELD

Further removes nutrients and impurities from the wastewater.



FILTERED

Water filters through the soil and eventually reaches groundwater after treatment.

TREATMENT

Effluent flows to a treatment system. Big Sky Water & Sewer District, Yellowstone Club, and Moonlight all have centralized treatment systems that treat water to a higher treatment level than the septic or onsite systems.



STORAGE PONDS

Treated wastewater is then stored for reuse during the summer season.



IRRIGATION

Water is currently reused on golf courses and forested land in the Big Sky area.



WATER REUSE

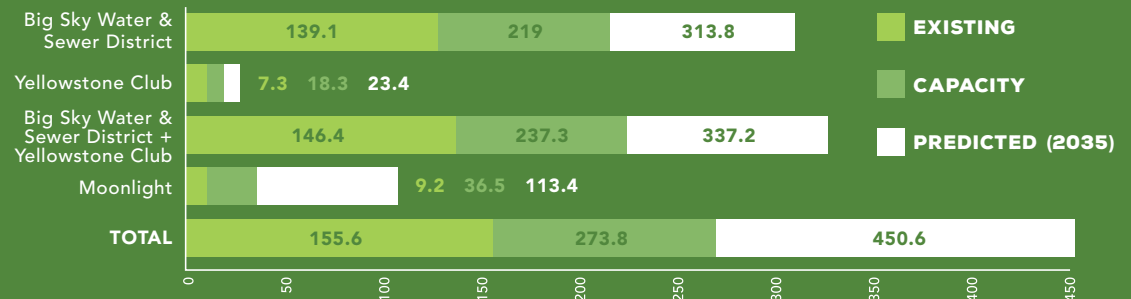
CURRENTLY, WATER IS RECYCLED ONCE. THE GOAL IS TO REUSE EVERY DROP OF WATER AGAIN AND AGAIN.

DEMAND WILL EXCEED CAPACITY AS SOON AS 2035

WATER TREATMENT FACILITIES IN BIG SKY



STORAGE & REUSE CAPACITY





BIG SKY WATER IMPROVEMENT PROJECTS

BIG SKY IS ALREADY IMPROVING ITS WATER KNOWLEDGE AND CONDUCTING WATERSHED IMPROVEMENT PROJECTS LIKE THESE.



WATER QUALITY MONITORING NETWORK

Tracking the health of the rivers through water quality monitoring and streamflow measurement. Gallatin River Task Force oversees the Gallatin system and the Madison Conservation District tracks Jack Creek in the Madison watershed.

GROUND WATER AQUIFER MANAGEMENT AND MODELING

Improved understanding and management of the aquifer under Meadow Village will enhance management of the most used aquifer in Big Sky. Montana Bureau of Mines and Geology is conducting the study and the Big Sky Water & Sewer District will use the management tools and information to help serve about 2,700 customers.



WEST FORK RESTORATION PROJECT

Restoring streamside habitat to filter nutrients and sediment to keep them from reaching the stream, in a partnership with Big Sky Resort, the Big Sky Water & Sewer District, Department of Environmental Quality, and the Gallatin River Task Force.



MUNICIPAL COMPOST

The Big Sky Water & Sewer District turns bio-solids left in the wastewater treatment process into high quality compost that is sold in the Big Sky area.



BIG SKY WATER CONSERVATION PROGRAM

Creating incentives such as rebates for indoor fixtures and outdoor irrigation to reduce water use at homes and businesses.



GALLATIN RIVER CLEAN-UP

Annual clean-up of the road corridor along the Gallatin River, led by the Gallatin River Task Force in partnership with the community.



DROUGHT MANAGEMENT PLANNING

Preparing to manage water wisely in times of limited community water supply and by stream flows.



OUSEL FALLS SAFETY & REVEGETATION PROJECT

The project will bring the Ousel Falls Trail back to its native state while providing a safer experience for all visitors.

MOOSE CREEK RESTORATION PROJECT

The first of many projects along the mainstem Upper Gallatin to restore streamside habitat and improve the safety and ease of river access for all users.



SNOWMAKING PILOT TEST

This pilot in 2011 was the first effort in Montana to reuse treated wastewater to build snowpack. Partners testing this approach included the Yellowstone Club, Big Sky Water & Sewer District, American Rivers, and the Department of Environmental Quality.