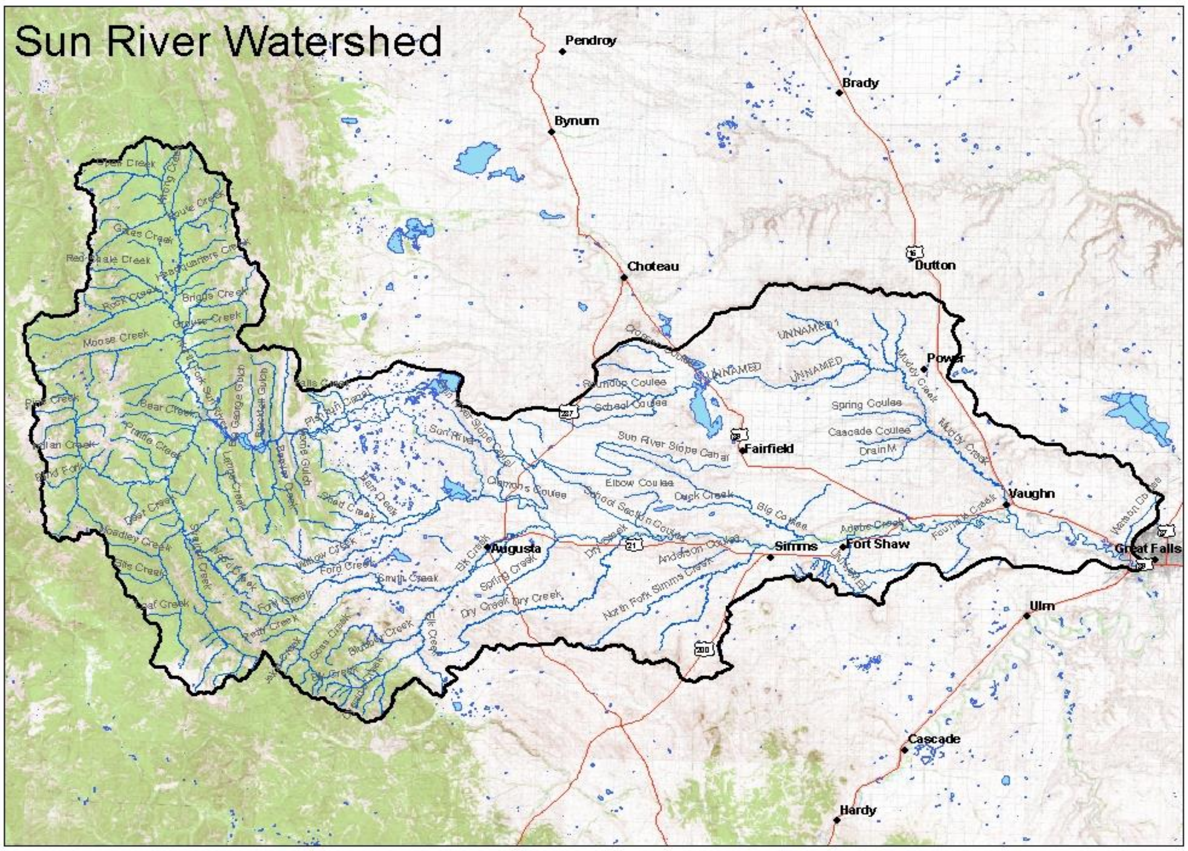
SUN RIVER WATERSHED GROUP SPECIAL STUDY REPORT



Prepared by:
Sun River Watershed Group in Cooperation with the U.S. Department of Interior Bureau of Reclamation, and Montana Department of Natural Resources and Conservation

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ACRONYMS

BLM	U.S. Bureau of Land Management
DEQ	Montana Department of Environmental Quality
DNRC	Montana Department of Natural Resource and Conservation
FSID	Fort Shaw Irrigation District
FWP	Montana Department of Fish, Wildlife & Parks
GID	Greenfields Irrigation District
MSU	Montana State University
NRCS	U.S. Department of Agriculture Natural Resource Conservation Service
NRIS	Montana Natural Resource Information System
Project	The Sun River Irrigation Project
Reclamation	U.S. Bureau of Reclamation
SRWG	Sun River Watershed Group
TU	Trout Unlimited
USFS	U.S. Forest Service
USFWS	U.S. Fish & Wildlife Service
USGS	U.S. Geological Survey

Executive Summary

In 2009, Reclamation, in consultation with the Sun River Watershed Group (SWRG), initiated the Sun River Special Study. The Special Study is an inventory and analysis of proposed measures that could be implemented to improve streamflow in the Sun River while maintaining or improving irrigated agriculture production. The study identifies a procedure by which water savings can be allocated between improved streamflow in the Sun River and irrigation needs. Although the purpose of the Special Study was not to fund projects, it does identify steps that can be taken towards implementing projects.

The Special Study identifies potential projects that might save water and provide shared benefits to agriculture and instream flow. This includes projects identified in previous studies, and those brought forth during the Special Study. The potential projects identified were placed into four categories:

1. Those that improve delivery system efficiencies
2. Reservoirs, which would include new reservoirs or improvements to existing reservoirs
3. On-farm efficiency improvements
4. Other water management measures

Information was compiled on the identified projects and the projects with the best potential were compared and ranked. The ranking did not strictly order the projects from highest to lowest, but partitioned projects into three groups based on when it might realistically be possible to implement the projects. Group 1 projects were those that ranked high and which the group could pursue now or in the near future. The second group of potential projects consisted of those which the group considered to be good projects overall, but where there was a lot more work to be done before the projects could be implemented. The third group consisted of projects that might have some potential, but were complex, possibly expensive and not workable at this time, but could still be considered in future work planning.

The last section of the report outlines a plan for further evaluating and implementing the projects. Basic procedures that might be followed, from feasibility studies through project construction, are identified. Because every project is different, this implementation plan is general rather than project specific. An important component of any project selected would be to develop a plan for sharing the saved water between irrigation and instream uses.

This Special Study has identified a number of projects that have the potential to conserve water, and provide shared benefits to irrigators and instream flow in the Sun River. Although no one project will solve all of the low-flow problems in the watershed, taken together, these projects might be enough to produce shared benefits and to increase Sun River instream flows at key locations, and during critical times. Implementing these projects will require a commitment from group members and working together as a team to obtain the necessary funding for design, authorization, and construction. Continued success of the project will require follow-through with operation and maintenance long after the projects are constructed. Developing agreements among parties that allow for sharing a project's water-saving benefits between irrigation and instream uses will be critical to the success of these projects, and for achieving the goals of the Special Study.

The Special Study identifies projects and recommends a path for achieving the goals of improving Sun River flows and agricultural productivity. While the Special Study was in progress, the FSID and SRWG pursued an available opportunity to fund and implement a water conservation project with shared benefits. This project is presented in the report as an example of how future projects could be implemented to achieve Special Study goals.

INTRODUCTION

Special Study Background

In 2007, Reclamation, in consultation with the Sun River Watershed Group (SWRG), proposed to initiate a Special Study in Federal Fiscal Year 2009. Reclamation worked with the Sun River Watershed Group to define the specific objectives of the proposed Special Study. The study was funded by Reclamation and work began in early 2009.

Special Studies address a variety of activities that are required to make responsible resource management decisions, but not intended to lead to Federal actions requiring subsequent or additional authorizations by Congress. Special studies are usually undertaken with non-Federal entities to address specific problems or opportunities. Reclamation, as a participant, has an obligation to explore the Federal role in the study.

The expected outcomes of the Special Study were the identification of proposed measures that could be implemented to restore flows to the Sun River to address fisheries and other environmental concerns while maintaining or improving the irrigated agricultural economy of the area. The Special Study identifies measures that required appraisal level or feasibility studies to implement. The study also identifies measures that could be implemented with non-federal funds but involve Reclamation facilities, which may require an appropriate level of environmental and cultural resources compliance. An example of a potential measure that includes Reclamation facilities is a canal lining project where the appropriate share of the water savings is dedicated to in-stream flow needs.

The SRWG had been engaged for at least a decade in seeking an acceptable solution to the issue of enhancing the environmental health of the Sun River Watershed without negatively impacting irrigated agriculture, which includes the water supply available to irrigation. Part of this work includes previous studies and investigations on a broad range of topics that seek to describe the existing condition and various studies on potential projects. The SRWG had been successful in completing numerous watershed projects to date, and the Special Study would build on other ongoing efforts in the watershed.

This Special Study describes the existing state of the watershed, identifies key issues and concerns, and describes and recommends projects. Part of the initial work on the study was to assemble, review and summarize all relevant previously completed studies and projects. This was done to avoid duplicating work already completed. For potential projects where little or no existing information was available, preliminary investigations have been completed and summarized in the Special Study to identify potential costs, water savings, key issues and concerns, and to develop recommendations.

The Sun River Basin

The Sun River Watershed is located east of the continental divide and south of Glacier National Park. It covers an area of 2,200 square miles (1,408,000 acres), with approximately 356 square miles (228,096 acres) in northwest Cascade County, 1,089 square miles (696,960 acres) in east Lewis & Clark County, and 755 square miles (482,944 acres) in southern Teton County. The Sun River starts at the confluence of the North and South Forks at Gibson Reservoir. Elevations in the headwaters in the Bob Marshall Wilderness area are as high as 9,000 feet. From Gibson Reservoir, the river meanders out of the mountains through rolling grass-covered foothills and farmland for 100 miles to its confluence with the Missouri River at the City of Great Falls at an elevation of about 1,800 feet. Along the way, the river passes through the communities of Augusta, Simms, Fort Shaw, Sun River, Vaughn, and Sun Prairie Village.

Ownership and land-use patterns

The headwaters of the Sun River watershed are mostly in National Forest Lands. As the river leaves the Rocky Mountain Front, land ownership changes to primarily private. The first major irrigator is the Broken O Ranch, which has one of the largest irrigation land bases of all the ranches in Montana. The Greenfields Irrigation District (GID) is the largest single irrigation entity in the watershed, followed by the Fort Shaw Irrigation District (FSID). Other irrigation districts and private irrigators also use Sun River water. Table 1 summarizes land ownership and irrigation patterns in the watershed.

Table 1. Land ownership and irrigated acreages in the Sun River Watershed (Acres).

US Forest Service......................		484,352
MT State Lands..........................		98,560
Reclamation		17,920
US Bureau of Land Management.....		5,120
USFWS		160
Irrigated Lands (Total)		117,700
GID	*87,000*	
Broken O Ranch	*17,000*	
FSID	*10,000*	
Sun River Ditch	*3,200*	
Rocky Reef Ditch	*500*	
Urban..................................		3,000
Other Private property		799,048
Total Acres		**1,525,860**

The Sun River Watershed Group and its Organization

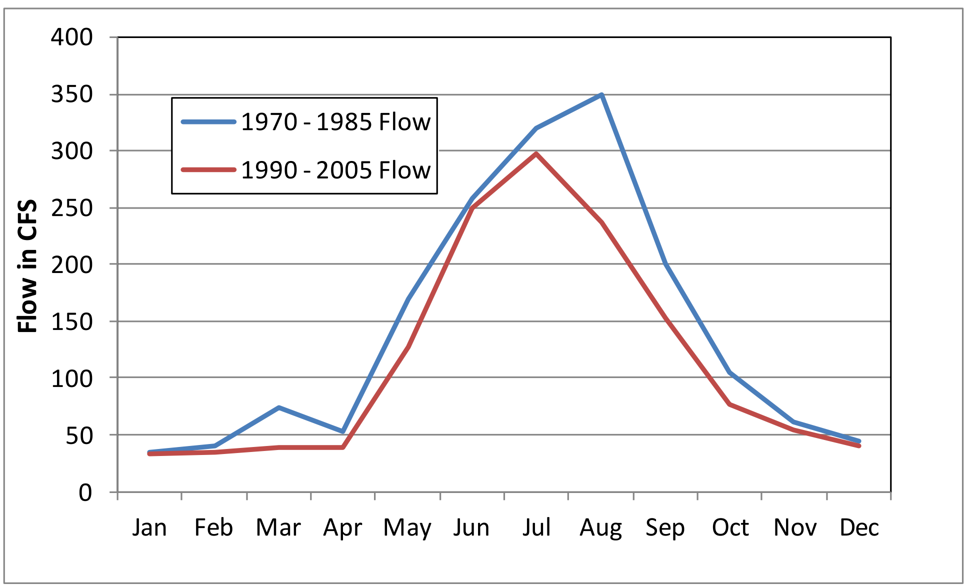
General Description and Mission **-** The Sun River Watershed Group is a nonprofit organization that was formed to help resolve natural resource problems using a consensus-based approach. The multi-stakeholder group strives to promote community-based efforts that will preserve quality of life and livelihoods, while promoting and enhancing the natural resources of the watershed. Participation in the organization is open to anyone or any group that is willing to work through collaboration. The group is funded through contributions from participating groups, business contributions, individual contributions, and government and private grants.

History and Accomplishments - Formed in 1994, the Sun River Watershed Group is the key to local involvement to resolve watershed natural resource issues, which include weeds, water quality and water quantity. In 1996 the SRWG officially formed as a 501 © (3) nonprofit organization to access additional funds to work on natural resource projects.

Historically, controversy was a way of life in the Sun River Basin, with battle lines drawn on the issues of water rights, erosion causes, water for fisheries and recreation, and water quality conditions. The tug-of-war began to change in 1994 when the Muddy Creek Task Force organized to break the status-quo and to provide a team approach to resolving one of the worst non-point source pollution problems in Montana. The group discovered innovative ways to tackle this problem which had stalemated for more than 30 years. From the beginning it was agreed that, once the Task Force had a good start, it would enlarge the boundaries and participation to encompass the entire Sun River watershed. In 1996, with the demonstration of the Muddy Creek success story, leaders in the basin felt it was time to expand efforts to the bigger watershed area. Soon, other success stories included the following:

- Elk Creek channel work to improve stream dynamics
- Willow Creek erosion control work to reduce high sediment loads entering Willow Creek Reservoir
- Mill Coulee channel work to improve stream dynamics and riparian health
- FSID water saving projects including conversion of open ditches to pipelines, canal lining and installation of measurement devices
- GID water savings projects including canal lining, conversion of open ditches to pipelines, wastewater pump-back systems, and installation of measurement devices
- The conversion of many flood irrigation systems to more efficient sprinkler systems
- A resulting reduction to irrigation and waste-water flows entering Muddy Creek (Figure 1) where high waste-water flows were causing serious erosion on that stream.

Figure 1. Average Monthly Flow for Muddy Creek at Vaughn for periods before and after implementation of water conservation measures.



Structure **-** The Sun River Watershed Board is comprised of the officers of president, vice-president, secretary and treasurer, and of individuals who have a vested interest in the watershed. Formal decisions by the group and by-laws for the core organization are made by an executive committee comprised of individuals from Cascade Conservation District, Teton Conservation District, Lewis & Clark Conservation District, Muddy Creek Task Force chair, and member-at-large. The executive board makes day-today decisions and handles all financial responsibilities. The current executive committee is comprised of Fay Lesmeister (Cascade Conservation District), Brad DeZort (Teton Conservation District), Mike Cobb (Lewis and Clark Conservation District), Skip Neuman (Muddy Creek Task Force), and at large member Michael Konen.

The rest of the SRWG participants can be anyone and everyone. Federal, state, and local agencies and groups participating in the group include the U.S. Bureau of Reclamation (Reclamation), U.S. Fish & Wildlife Service (USFWS), U.S. Bureau of Land Management (BLM), U.S. Forest Service (USFS), Montana Department of

Environmental Quality (DEQ), Montana Department of Natural Resources and Conservation (DNRC), Montana Fish, Wildlife and Parks (FWP), Montana State University (MSU) Extension Service, and many individual landowners.

Watershed Group: From scoping meetings and subsequent work meetings the Sun River Watershed Group objectives (in no particular order) are to:

1) Maintain and/or improve a viable agriculture economy
2) Control noxious weed infestations in the Sun River Watershed
3) Reduce the sediment loads into the Sun and Missouri Rivers
4) Improve the overall water quality of the Sun River
5) Improve the flows in the Sun River
6) Improve the fisheries of the Sun River

Sun River Water Supply and Water Use

Most of the flow of the Sun River originates in the higher-elevation headwaters of the watershed in the Rocky Mountains west of Great Falls, Montana. The two primary tributaries are the North and the South Forks which join to form the Sun River at the head of Gibson Reservoir on the Rocky Mountain Front. These two streams produce runoff and consistent base flow, due to the higher precipitation and snow retention that occurs at the higher elevations in the mountains.

Photo 1: The North Fork of the Sun River above Gibson Reservoir.

Gibson Reservoir provides storage of the combined flow of the North and the South Forks of the Sun River. It has a capacity of about 96,477 acre-feet and is operated and maintained by GID in accordance with their contract with Reclamation. Reclamation provides oversight during spring runoff, while GID operates the reservoir during the irrigation season to meet irrigation demands on GID, while passing the water needed for senior irrigation water rights on the Sun River downstream. Water typically is stored in Gibson during two periods: following the irrigation season in the late fall and winter, and during the snowmelt-runoff period in the spring. Storage builds up slowly during the fall, winter and early spring, and quickly during snowmelt runoff in May and June. Typically the reservoir begins releasing stored water for irrigation demands starting from late May to early July, with storage releases beginning in June during most years. Releases continue until the early fall, when the reservoir typically reaches its lowest level.

Just downstream of Gibson Reservoir, the Sun River Diversion Dam diverts water through a 1,400 cfs capacity canal to Pishkun Reservoir, an off stream Reclamation Reservoir with an active storage capacity of about 30,686 acre-feet. From there, the water is reregulated and delivered to the Greenfields Irrigation District, which irrigates about 83,000 acres. Some of the water that is diverted from the Sun River at the Diversion Dam also goes to Willow Creek Reservoir, with an active storage capacity of about 31,847 acre-feet. Water from Willow Creek Reservoir is released back to the Sun River to ensure there is enough water in the river for senior users and for the Fort Shaw Irrigation District, which has some storage rights and irrigates about 10,000 acres. The main diversion dam for the FSID is located upstream of the town of Simms. The Broken O Ranch also irrigates a considerable acreage of land with Sun River water, which is diverted at several locations between the mouth of Willow Creek and the Fort Shaw Diversion Dam.

Photo 2. Gibson Dam and Reservoir near the end of the irrigation season.

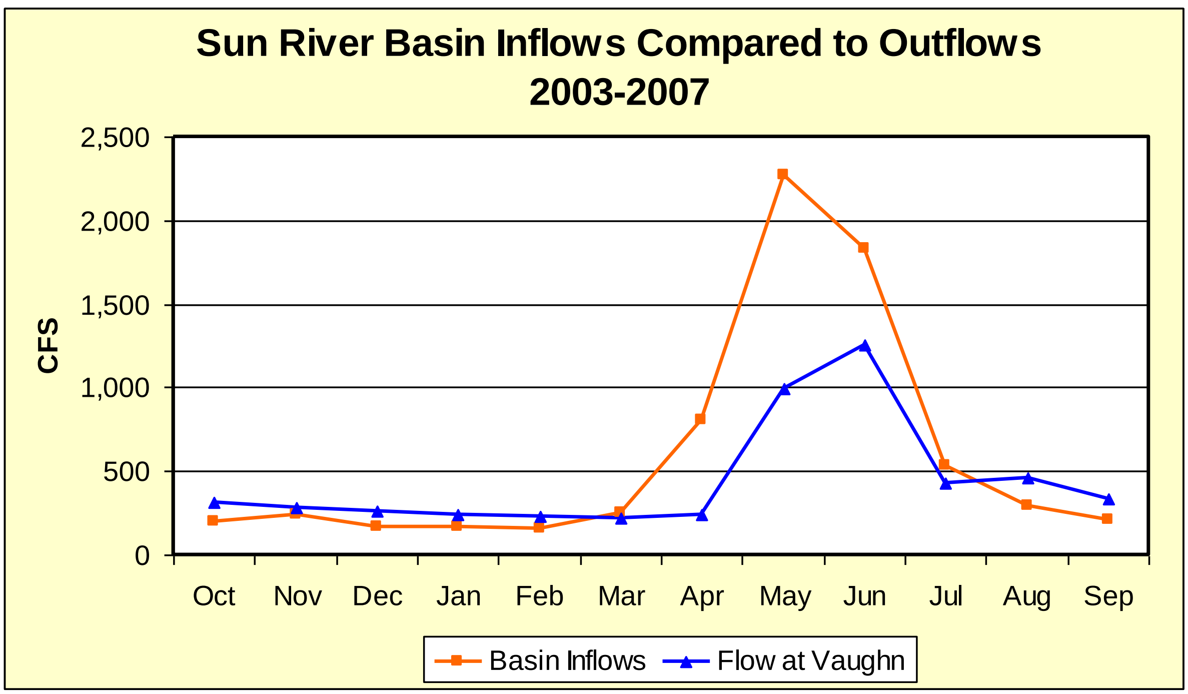
The inflow to Gibson Reservoir from the North and South Forks of the Sun River is by far the largest source of water in the basin. For the period from 1930 through 2007, about the time that the Special Study began, the average annual inflow was approximately 595,000 acre-feet. On average 85% of this water was produced during the April-through-September period, but a substantial amount of the winter inflow to Gibson Reservoir is stored for release during the following irrigation season. Elk Creek, the largest higher-elevation Sun River tributary, contributes about 5-to-10 percent of the total basin flow. Nilan Reservoir, a DNRC project with a capacity of about 10,000 acre-feet, stores and releases water from the Ford and Smith Creek tributaries for irrigation in the Elk Creek drainage.

The USGS, Reclamation, DNRC, and the SRWG all collect streamflow data in the watershed. These data are used to characterize basin water supply and water use. In addition to the Sun River proper, flow data are collected for a number of tributaries including Elk Creek, Big Coulee, Adobe Creek, Mill Coulee, and Muddy Creek. Map 1 depicts the locations of the gaging stations that are operated in the Sun River watershed, as well as the various reservoirs, main irrigation supply canals, and irrigation districts.

Water Supply for Irrigation

Hydrologic data for a 5-year period (2003-2007) were used to characterize the limitations of the Sun River water supply in meeting irrigation demands. This 5-year period is representative of more recent drought conditions. The annual average inflow to Gibson Reservoir during 2003-2007 was 402,000 acre-feet, or approximately 190,000 acre-feet less than the long-term average. Figure 2 compares high elevation Sun River watershed inflows to Sun River outflows for the period. Total inflows include that from the North and South Forks of the Sun River, plus an additional component that flows in from around the Gibson Reservoir area. Total inflow also includes Elk Creek, which contributes to Sun River flows below the Diversion Dam. Outflows are from the Sun River at Vaughn gaging station, near where the Sun River joins the Missouri River.

Figure 2. Sun River Basin inflow/outflow comparison.

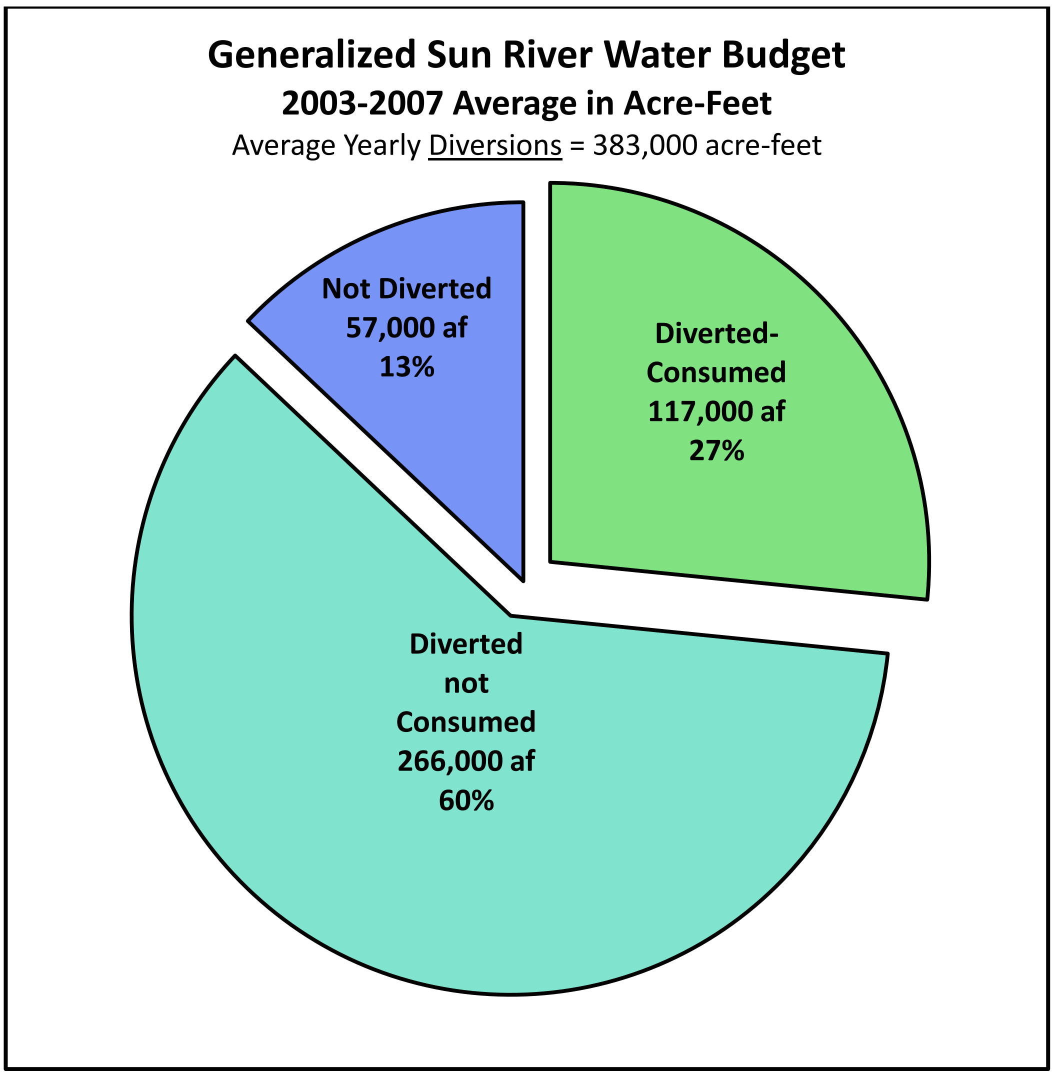


During most of the spring and summer, there is more water flowing into the basin from the higher elevations than leaves the basin at the mouth of the Sun River. This is because during the spring water is being stored in Gibson Reservoir, and because water is being used for irrigation by GID, Broken O Ranch, FSID, Elk Creek water users, Rocky Reef Ditch users, and Sun River Valley Ditch Company users. There are about 120,000 acres irrigated in the basin overall. During the fall and winter months, outflows from Gibson are reduced but the flow of the Sun River progressively increases downstream. This increase is due primarily to irrigation return flows, coming back through the groundwater, which are delayed by the time it takes the water to flow through the aquifer systems.

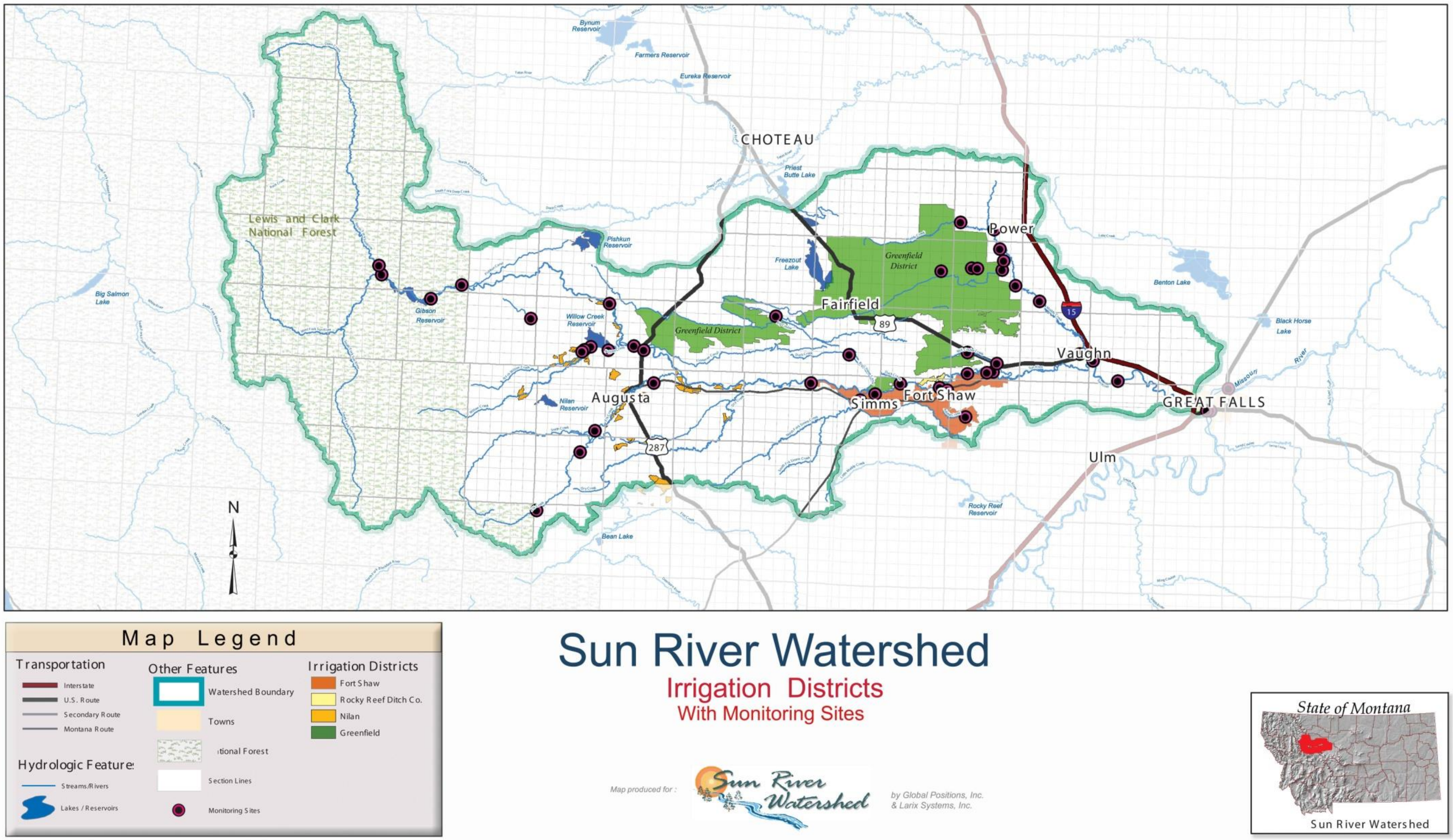
Sun River Basin inflow volumes for the 2003-2007 period averaged about 440,000 acre-feet per year, while outflows averaged about 320,000 acre-feet per year. Figure 3 is an approximation of an annual volumetric water budget for the watershed and depicts where the water in the basin goes. All but about 13 percent of the water in the Sun River was diverted at least once for the purpose of irrigation. Most of the 57,000 acre-feet that wasn't diverted was flow during the fall and winter, and spring runoff that could not be captured or stored. Of the water diverted for irrigation, approximately 27 percent or about 117,000 acre-feet was consumed. This works out to almost one acre-foot of water consumed per acre of irrigated ground, assuming 120,000 acres irrigated. The rest of the flow (60 percent or 266,000 acre-feet) was water that was diverted and not consumed, and that left the basin as return flow.

It is estimated that it would take about 450,000 acre-feet of controllable flow to meet all of the irrigation needs in the basin during a typical growing season. This would assume an overall irrigation efficiency of about 40 percent. Having this volume available would allow irrigators to get sufficient water to their crops, with the plants consuming about the 1.5 acre-feet per acre irrigated (about 175,000 acre-feet total). This would provide near optimal crop production. Unfortunately, this volume of water is not available during many years.

Figure 3. Generalized Sun River water budget: 2003-2007.



Map 1. Sun River Watershed map including locations of irrigation districts and flow monitoring sites.



Fisheries and Instream Flow Needs

Montana Fish, Wildlife and Parks (FWP) manages the Sun River fisheries. FWP estimates that the main stem of the Sun River supports about 10,000 angler days per year. The primary game fish in the Sun River are rainbow and brown trout. Low-flow conditions in the river limit the trout populations to about 40-120 fish over 8 inches per mile. However, fish that do survive reach large sizes with over half of the fish being 15 inches or larger. A goal of the Sun River Watershed Group is to increase fish populations to 400 fish per mile. Doing so would require improving flow conditions in the river.

Table 2 contains FWP's recommended minimum and absolute minimum flows for the Sun River main stem. The recommended minimums are guidelines; there is no water right to protect these flows. Flows at these rates or higher would maintain food production at or near optimum levels for the aquatic community and provide bank cover, and spawning and rearing habitat. FWP does have a water right (a water reservation) for the absolute minimum flow recommended, which identifies the flow below which there is a rapidly declining level of aquatic habitat potential that provides for only a low fish population. However, these rights have a 1985 priority date and are junior to almost all irrigation water rights in the watershed.

Table 2. Recommended minimum and absolute minimum Sun River flows by river reach.

	Recommended Minimum CFS	Absolute Minimum CFS (Water Reservation)
Diversion Dam to Mouth of Elk Creek	220	100
Elk Creek to Mouth	220	130

In many years it has been difficult to consistently maintain the recommended minimum or even the absolute minimum flow in all reaches in the river year round. One persistent difficulty is during the winter period when GID is storing water in Gibson Reservoir for the upcoming irrigation season. Because inflow to the reservoir typically is at its lowest during this time of the year, comparatively little water is available to store or release to begin with. The operators are going into the winter with little knowledge of what snowpack will accumulate during the winter and what the spring precipitation will be. Reliable information on mountain snowpack will not be available until the late winter or early spring. Because the winter inflow to Gibson Reservoir can be predicted based on the fall reservoir inflow (Reclamation 2007), reservoir releases can be set during the fall and winter to achieve a desired storage level prior to the beginning of spring runoff. If the reservoir ended the previous irrigation season at a very low level and the projected inflow is low, then operators typically store much of the winter inflow to reduce the risk of not filling the reservoir to full pool by the end of spring runoff.

Typically, an effort is made to maintain a minimum winter release from Gibson Reservoir of at least 100 cfs. After the February 1st water supply forecast, winter releases can be adjusted, if necessary, based on the forecast and the reservoir level at the time. However, if winter conditions are severe, the potential for ice scouring of the banks may prevent the dam operators from increasing flows. During years when reservoir storages and winter inflow is low, winter releases have been cut back to around 75 cfs. In extreme cases, the outflow has been reduced to the absolute winter minimum of 50 cfs. Because there typically is not a lot of irrigation return flow or tributary flow added to the river between the Sun River Diversion Dam and the mouth of Elk Creek, low winter releases result in less than desirable winter flows that limit fish populations in the river.

During the irrigation season, the flow that goes over the Sun River Diversion Dam for senior irrigation water rights generally keeps the river flow above recommended minimums downstream to the FSID Diversion Dam. Below the FSID Diversion Dam, low water levels and high water temperatures often are a problem during the irrigation season. River managers attempt to maintain a minimum flow of 50 CFS at the Sun River at Simms gaging station, although flow has dropped below this level during recent years. Progressing downstream, the river flows steadily increase due to irrigation returns from GID, FSID, Broken O Ranch, and other irrigators.

Water Appropriations

Reclamation's Sun River Project

The Sun River Project (Project) facilities, authorized under the Reclamation Act of 1902, provide the capability to store, manage and utilize federal water rights in the Sun River drainage. The major Project facilities, constructed, owned by Reclamation, and operated by GID, are managed to deliver Project water by contract to users. Two irrigation districts are served by the Project, GID and FSID. GID contains approximately 87,000 irrigated acres, and FSID contains approximately 10,000 irrigated acres. The Project is the largest water user in the basin.

GID works with contract holders to set annual water allotments based on the latest water supply forecast. Because of the high demands compared to the water available in the basin and the priority of the Project, it often uses the bulk of flow of the Sun River.

Other Irrigation Water Rights

Major consumptive private Sun River water users include the Broken O Ranch, Rocky Reef Canal Co, and Sun River Valley Ditch Co. The Nilan Water Users Association operates Nilan Reservoir, a State of Montana water project, and irrigates approximately 10,000 acres, mostly in the Elk Creek tributary drainage. There also are numerous private water rights for irrigating relatively smaller parcels of land, and for stock and domestic use. With the exception of the Broken O Ranch, most of these rights are junior to those associated with the Sun River Project.

Water Reservations/Reserved Water Rights

Water reservations have been granted in the Sun River basin for current and future beneficial uses, including maintenance of minimum streamflow for fishery purposes. Water reservations were only granted to political subdivisions, the State of Montana or its agencies, or to the United States or any of its agencies. Water reservations maintain a 1985 priority date even though the water may not be put to beneficial use for decades. These rights are junior when compared to the larger irrigation water rights in the basin, and there is often insufficient flow left for them. Table 3 lists water reservations in the Sun River watershed.

Table 3. Water Reservations in the Sun River Watershed.

Reservant	Purpose	Source	Rate CFS	Volume AF/yr	Acres
City of Great Falls	Parks irrigation	Sun River	4.45	233.5	
Montana DFWP	Instream flow	Elk Creek	16		
		Ford Creek	12		
		Willow Creek	3		
		NF Willow Creek	3		
		Sun River: Diversion Dam to Elk Creek	100		
		Sun River: Elk Creek to mouth	130		
Cascade County CD	Irrigation	Sun River	7	991	388
Lewis and Clark County CD	Irrigation	Elk Creek	1	151	60
Teton County CD	Irrigation	Muddy Creek	12	1785	804
	Irrigation	Sun River	3.7	542	252

Water Storage

Water storage plays a major role in the Sun River Basin. Storage projects include Gibson, Pishkun, Nilan, and Willow Creek reservoirs. Water is stored during the winter and runoff periods, and then released to supply irrigation water to hundreds of users along the river and canal system. Water storage can also play a crucial role for recreation interests and fisheries in the basin, if releases coincide with times of need. Aside from direct recreation benefits at the reservoirs, releases for irrigation purposes can also indirectly increase stream flows when natural channels are used for conveyance or carry irrigation return flow.

Table 4 contains a summary of consumptive and non-consumptive water rights in the basin, which demonstrates the variety of uses and the volumetric extent of the various uses. More details on individual water rights can be found at the following DNRC web site: http://dnrc.mt.gov/wrd/water_rts/default.asp.

Table 4 - Sun River Watershed water rights summary.

Purposes	Number of Rights	Volume (Acre-Feet)	Acres Irrigated	Percent of Total Rights	Percent of Total Volume	Comments
Agricultural Spraying	2	1		0.04	0.00	
Commercial	72	752	12	1.5	0.04	
Domestic	1338	5,550	1,091	28.7	0.28	Includes wells
Fire Protection	5	204		0.11	0.01	
Fish and Wildlife	37	14,849		0.79	0.76	
Fishery (instream flows)	11	201,458		0.24	10.3	
Industrial	10	423	5	0.21	0.02	
Institutional	15	6	2	0.32	0.00	
Irrigation	756	1,457,362	521,882	16.2	74.7	Some rights overlap
Lawn and Garden	262	1,269	339	5.61	0.07	
Mining	1	1,814		0.02	0.09	
Multiple Domestic	12	173	3	0.26	0.01	
Municipal	23	10,991		0.49	0.56	
Observation & Testing	1	1			0.00	
Other Purpose	17	13		0.36	0.00	
Power Generation	3	203,674		0.06	10.44	
Recreation	15	270		0.32	0.01	Some rights overlap
Stock	2072	53,028		44.4	2.72	
Wildlife	14			0.30	0.00	
Waterfowl and Wildlife	3	98		0.06	0.00	
Totals	**4,669**	**1,951,936**	**523,334**	**100**	**100**	

Upper Missouri River Closure

In 1993 the Montana Legislature closed the Upper Missouri River drainage, including all tributaries, to most new appropriations of water (85-2-343, MCA). The Sun River and all water flowing into it is one of the affected tributaries. The closure was enacted due to water availability problems, over-appropriation, and a concern for protecting existing water rights, including downstream hydropower rights. Certain exemptions allow new water rights (permits) to be issued for limited non-consumptive, water storage of high spring flows, and other minimal consumptive purposes that do not adversely affect existing water rights. The closure also has an exemption for new permits that use water from the Muddy Creek drainage, if the proposed use will help control Muddy Creek erosion. With the exception of the Muddy Creek drainage, the closure makes new permits for additional consumptive uses from the Sun River basin unlikely, other than to implement water reservations. Projects that are pursued as a result of this Special Study will need to be evaluated, during project planning, to determine if water rights changes or new water rights are needed, and if any of the projects might be subject to the Upper Missouri River Closure.

Previous Investigations Leading to the Special Study

The Water Management subgroup of the Sun River Watershed Group was formed in 2003. The goals of the subgroup are to: 1) improve flows in the Sun River for fisheries, and 2) while accomplishing this goal, maintain and/or improve irrigation production. The members of the subgroup represent a range of stakeholders, including GID and FSID, Reclamation, DNRC, the Broken O Ranch, Montana Fish, Wildlife and Parks, Trout Unlimited (TU), NRCS, and other private irrigators and interested citizens.

In working towards its goals, the subgroup operates, maintains, and helps fund the flow monitoring network in the watershed. This includes river and tributary stream gages, measurement of flows in irrigation canals and ditches, and the measurement of irrigation return flow. With this information, the group has developed a much better understanding of the hydrology of the Sun River system. Annual water budgets for the basin have been developed and presented to the group. Collecting, compiling, and understanding all this information is necessary for estimating what benefits various water conservation measures might provide, especially in regards to improving the flow in the Sun River.

A water management analysis was conducted by a consultant to the group during 2004 (Snowcap Hydrology 2004). This included a review and analysis of existing flow data, irrigation water management practices, and Reclamation project evaluations. Recommendations included improving irrigation efficiencies and reducing canal spillage, improving the ratio of delivered water to diverted water, using climate data to better anticipate crop needs, better use of water supply forecast information, reassessing recommended minimum outflows from Gibson Reservoir, better coordination of the release of stored water, and better education on efficient irrigation practices.

To better understand water diversions and returns to the system as a whole, the group conducted synoptic flow measurements during the 2004 (a lower quartile flow year) and 2005 (a year in the median range). Over two-day periods, when flow and diversion conditions were relatively stable, the flow of Sun River, its tributaries, and diversion were measured at various locations (up to 31 locations) throughout the watershed. The goal was to obtain snapshots of flow patterns in the watershed at the time of the synoptic measurements. The measurements were helpful in identifying where the river was gaining and losing water, and whether these gains and losses were predictable. Five synoptic measurement snapshots were made, including snapshots prior to the irrigation season, during the mid irrigation season, and near the end of the season (DNRC 2006).

In follow-up to recommendations in the Snowcap Hydrology Water analysis report, during 2006 and 2007 Reclamation used its River Operations Model, SUNAOP to investigate Gibson Reservoir winter operations and to evaluate whether instream flows could be increased in the Sun River below the Sun River and Fort Shaw Diversion Dams during the irrigation season (Reclamation 2007). The study found that it would be difficult to modify operations to increase instream flow during the irrigation season below the Sun River and Fort Shaw diversion dams without increasing irrigation shortages during drier years. In considering non-irrigation season operations, a water balancing method was developed through the study that could provide noticeable improvements in winter fishery flows during average and above average years, while protecting the irrigation water supply in low runoff years. Working from the Snowcap Hydrology report, Reclamation subsequently established a water-balance method to set minimum winter outflow rates from Gibson Reservoir. (Reclamation

2007b).

Although the Reclamation studies identified these operational measures for improving winter flows during many years, the studies also found that it would be difficult to increase Sun River instream flows to desired levels during the driest years. To start identifying other potential ways of improving Sun River flows, a “brainstorming” session was held by the Water Management Subgroup during September, 2006. The intent of this session was to generate ideas on ways to improve Sun River instream flow, while maintaining current levels of agricultural productivity. The session identified a number of potential structural and nonstructural measures, and discussions moved on to how some of these measures might be implemented.

In follow-up to this meeting, tasks were assigned and preliminary investigations into some ideas were begun. Investigations into seepage from the Sun River Slope Canal were conducted in 2007, with considerable seepage losses identified (TD&H, Inc. 2008). Near that same time, Reclamation and GID initiated an appraisal study of enlarging the storage capacity of Pishkun Reservoir, to investigate the potential to store and deliver more water, with some of the savings possibly designated for improved river flow. The FSID also began investigating ways of improving the efficiency of its water delivery systems, including the K-ditch (TD&H, Inc. 2010).

Studies were also conducted by the SRWG to identify the major sources of waste-water and irrigation return flows to the major tributaries on the lower portions of the Sun River. A gaging network was established on tributaries to Muddy Creek by Montana State University Extension Water Quality to identify primary sources of flow and sediment to that stream, (MSU 2006, 2007, and 2008). Similar investigations were conducted on Big Coulee by MSU (MSU 2007b and 2008b). These studies identified which drainages were producing the most water and sediment, and are helpful in focusing water-conservation efforts. DNRC has been gaging Mill Coulee flows since 2001in order to understand the patterns of return flow and unused water from that stream that returns to the Sun River. The Sun River Watershed Group has been monitoring tributary return flows from FSID for similar purposes.

In order to tie all this information together and develop a plan for future actions, the Watershed Group looked at incorporating all the ongoing efforts and future potential projects into a coordinated Special Study during the later part of 2008. The study was funded by Reclamation, with a 50-50 non-federal cost share. The Special Study was to be an inventory and analysis of proposed measures that could be implemented to improve streamflow in the Sun River while maintaining the irrigated agriculture economy of the area. Although the purpose of the Special Study was not to fund project implementation, it does include looking at steps that can be taken towards project implementation. A critical part of the study is the development of a procedure by which project water savings can be allocated between improved streamflow in the Sun River and irrigation needs.

PROJECT IDENTIFICATION AND EVALUATION

The first task of the Special Study was identifying all potential options that might result in saved water and shared benefits to agriculture and instream flow. This included those projects identified in previous studies, and those brought forth in the initial brain-storming session.

With the options identified, a procedure to initially screen the projects was developed. The intent was to remove projects from the analysis that had a low potential to provide shared benefits or feasibility before devoting resources to them. The initial screening asked the following questions:

- Does the project have the potential to provide additional water for irrigation and instream flow?
- Does the project have the potential to affect water users or instream flow?
- Are there any insurmountable hurdles to implementing the project?

The answer to the first two questions needed to be affirmative and the answer to the last question needed to be no. After considering these criteria, a number of the projects were dropped from further consideration. Some more general basin-wide water management efforts, such as installing and maintaining measuring devices, were not evaluated in the Special Study because these efforts are ongoing and it would be difficult to quantify actual amounts of water saved through these measures.

Following the initial screening, potential projects that remained on the list were categorized by project type and evaluated to assess potential costs, benefits, and other opportunities and constraints. For many of the projects identified, there was little if any available information to assess them appropriately. A consultant was hired to assist with the Special Study and help with a preliminary engineering assessment of potential projects. The intent of these assessments was to develop a preliminary project concept, including an estimate of project dollar costs and annualized costs, and to estimate the benefits that the project could provide in terms of saved water. Enough information needed to be compiled to describe each project's potential and to compare projects. Other potential benefits, such as water quality, also were assessed, but in a more subjective way. The potential projects were placed into the following four categories:

1. Those that improve water delivery system efficiencies
2. Reservoirs, which would include new reservoirs or improvements to existing reservoirs
3. On-farm efficiency improvements
4. Other water management measures

Once the projects were identified and the necessary information compiled, a spreadsheet was developed to make ranking and comparing the projects easier. The spreadsheet included the initial screening criteria and other criteria to assess costs, and potential water savings. The spreadsheet can be found in Appendix A.

Developing a methodology for allocating saved water was an important part of the Special Study. An overall purpose of the Special Study is to identify and set out procedures for implementing projects that result in the joint benefits of improved agricultural productivity and enhanced streamflow in the Sun River. The methodology developed and described later in the report strives to achieve benefits that are equitably shared.

The following was the initial list of potential projects, by category.

Potential Projects by Category

<u>Category 1 – Delivery Systems:</u>

1. **Canal lining**
2. **Control structure on the larger irrigation district canals**
3. **Automation of water delivery systems including field headgates**
4. **Pump-back systems to reuse waste-water that would otherwise flow to Muddy Creek and other tributaries**
5. **Replace some ditches with pipelines to deliver water to farm headgates or new sprinkler systems**

<u>Category 2 – Reservoirs:</u>

1. **Increase the height of Gibson Dam to increase the storage of Gibson Reservoir**
2. **Increase the ability to fill and release water from Willow Creek and Pishkun Reservoirs and increase efficiencies through timing of the fill**
3. **Build new off-stream water storage reservoirs.**
4. **Build new or expand re-regulating reservoirs within irrigation districts**
5. **Increase the height of the Pishkun Dikes to increase the storage of Pishkun Reservoir.**
6. **Review the water levels that are maintained to protect reservoir-outlet fish screens at Pishkun Reservoir; see if there may be alternative ways to protect the fish screens.**

<u>Category 3 – On-Farm:</u>

1. **Improve on-farm irrigation/pivot efficiency through training and improved equipment.**
2. **Convert flood irrigation systems to sprinkler irrigation**
3. **See if improvements can be made in how farmers order water from their irrigation district; models for anticipating orders and actual ordering process.**

<u>Category 4 – Other Water Management Measures:</u>

1. **Water banking concept: allow water users to store water in Gibson for later instream flow release, especially during drought years.**
2. **Buy out senior water rights that would like to change their water rights or lease their rights to instream uses.**
3. **Look at ways to manage risk, i.e. insurance for water users to mitigate increased risk of not filling Gibson Reservoir due to higher winter release rates:**

Project Screening and Potential Projects to Investigate Further

Projects that were not investigated further in this Special Study

The following potential projects were identified in the initial stages of the Special Study but were not pursued further because they did not pass the initial screening criteria. Each project is described below, with a short discussion of the reasons why the project was not pursued further.

Increase the height of Gibson Dam to increase the storage of Gibson Reservoir:

Gibson Reservoir fills and spills during most years. A larger reservoir might be able to capture and store more water for the upcoming irrigation season, or carry-over stored water from a dry year that follows a wetter year. When there are back-to-back drought years though, a larger Gibson Reservoir probably would not capture and supply more water because the reservoir might not even fill to the existing 96,477 acre-feet capacity during either year.

Gibson is a concrete-arch dam with a drop-inlet spillway. Modification to these structures to allow for a higher pool level would be very expensive. Additionally, there may be topographic limitations to increasing the full-pool elevation, and concerns about backing more water into the surrounding National Forest including the Bob Marshall Wilderness Area. Using a computer simulation model of the Sun River system to determine “firm” reservoir yield for various sizes and to model what an optimal reservoir size might be could provide more information to determine if this option should be explored in more detail in the future. Although the enlargement of Gibson might have some merit in the future, the length of time and high costs just for project evaluation precluded pursuing this option through the Special Study.

Build new off-stream water storage reservoirs:

The intent here was to investigate sites on the middle portion of the Sun River where surplus high flows from tributaries could be captured and diverted to new off-stream reservoirs and later released into the Sun River. Group members asked that the potential of two sites be investigated: one on Simms Creek, and the other in Cutting Shed Coulee. After preliminary investigation, it was determined that neither of these sites could store enough water to improve instream flows in the Sun River, and that construction costs would be prohibitive. With that determination, the group removed these potential projects from further investigation at this time.

Review the water levels that are maintained to protect fish screens at Pishkun Reservoir; see if there may be alternative ways to protect the fish screens:

There are screens at the outlet of Pishkun Reservoir to keep fish from entering the Sun River Slope Canal. During the winter, the water level above these screens needs to be high enough to prevent ice damage. It was initially thought that this was resulting in an additional volume of storage that had to be carried to the fall and was inaccessible for delivery to GID during the irrigation season. Although water levels may be important to protect the fish screens, GID can place protective berms around the screens or lower the water level enough so ice does not reach the screens. After discussions with GID, the project was not considered further because protection of the fish screens was not having an effect on reservoir storage or water deliveries.

Look at ways to manage risk, i.e. insurance for water users to mitigate increased risk of not filling Gibson Reservoir due to higher winter release rates:

Following dry years, when Gibson Reservoir storage is depleted and streamflow into the reservoir is low, winter releases from Gibson Reservoir are reduced to below 100 CFS. Most of the time, the upcoming winter and spring will produce enough snow and rain to fill the reservoir the following year. Although the low winter release will have turned out to have been unnecessary during most years, it is implemented because, for GID irrigators, it insures that Gibson Reservoir fills in all years. Simply put, if a very dry winter and spring were to follow the previous dry year that depleted reservoir storage, Gibson Reservoir would not fill. The idea behind this option would be to allow instream interest to a guaranteed 100 cfs winter reservoir release, if they were willing to take out insurance on the reservoir filling. In years when the reservoir did not fill because of the increased winter release, GID irrigators would be compensated for the agricultural water value lost due to the higher winter release. The alternative was not pursued further due to the lack of an established procedure, lack of interest, and because both instream flow interests and GID Board did not consider it workable at this time. GID Board discussed this option and was of the opinion that it would be too difficult to manage crop-loss claims from irrigators during the years when the reservoir did not fill.

Water banking concept: allow water users to store water in Gibson for later instream flow release, especially during drought years:

Water banks broker voluntary transactions between people trying to sell or lease water rights and those trying to purchase rights or leases. A bank also can become a depository of water rights that are available for lease or transfer, and helps to set prices for purchase and sale. Montana does not have a water banking system, but agricultural water rights can be leased for instream uses between private parties. Although water banking is not prohibited, this option was dropped because there currently is not a water banking system in Montana. Purchasing or leasing water rights by other means is discussed under Category 4: Other Water Management Measures.

See if improvements can be made in how farmers order water from their irrigation district; models for anticipating orders and actual ordering process:

Within the irrigation districts, individual water users can order water with 48-hours advance notice or cancel water deliveries from the district with 24-hours advance notice. Often, the orders or cancellations come too late for the operators to balance flows in the ditch systems, which results in waste-water spills to coulees that feed drainages such as Big Coulee, Mill Coulee, and Muddy Creek result. With longer lead time for water orders and order cancellations, ditch riders might be able to reduce these operational spills. Implementing such a procedure may require incentives to encourage individual farmers to participate. Although changing the ordering system may have some merit in the future, the GID board felt the current system is working and that modifying the system would not result in substantial water savings at this time.

Projects that Passed to Initial Screening Phase and were Analyzed Further in the Special Study

The following section describes projects that passed the initial screening and were analyzed further in the Special Study. Each project and its potential costs and benefits are described. The projects are ordered by category. All cost figures are preliminary.

Category 1: Delivery System Improvements

Delivery systems include the main canals which divert water from the source to the irrigated lands, and the lateral ditches, pipelines and field ditches which distribute the water within the irrigated land base. Water is lost from canals and ditches as seepage and evaporation. Because evaporation losses are generally minor, they were not considered further. Reducing the amount of water lost at the end of canals, ditches and pipelines as operational spills presents another opportunity to conserve water through delivery system improvements. Operational spills occur when there is excess water within the system that can’t be used, such as immediately following a rainstorm. In other cases, operational spills occur because there is a certain amount of carriage water required to get water to the very end of a system, especially on large irrigation districts. The following are potential projects that fall in the Delivery System Improvements category.

Line the Sun River Slope Canal near Augusta: The Sun River Slope Canal conveys water from Pishkun Reservoir to GID irrigated lands. The canal is 39 miles long with a capacity of 1,600 cfs. It was built between 1917 and 1919 and is thought to lose substantial amounts of water to seepage. A study by the Sun River Watershed Group investigated seepage in an 8.8 mile length of the canal from the Highway 287 Bridge near Augusta to the beginning of the Spring Valley Canal. Preliminary water loss estimates from the 2007 study estimate that 10,000 to 12,000 acre-feet is lost annually to seepage in this section of canal (TD&H, Inc. 2008). This option would line a 3-mile length of the canal which was determined to have particularly high seepage rates. A synthetic liner would be used. The overall cost of the project might be $3,000,000.

Use J-Lake Storage to reduce waste-water flows to Muddy Creek: J-Lake is a re-regulating storage reservoir on the headwater of Spring Coulee near the East Bench area of GID. Flows to Muddy Creek from Spring Coulee are estimated to be up to 20,000 acre-feet per (MSU 2006, 2007, and 2008) year, much of which is return flow and waste-water losses. An existing J-Lake dam and reservoir captures some flow and wastewater from Canal laterals and drains, and passes this water either into a GID lateral canal, where it can be used for irrigation, or into Spring Coulee, where it cannot be used and flows as waste-water into Muddy Creek. Currently, J-Lake only has about 20 acre-feet of storage capacity and it is difficult to manage the flow of waste-water into Spring Coulee with this small volume of storage and with the existing configuration of the J-Lake dam structure. This option would increase the height of the J-Lake dam and dikes, and modify the dam control structures so that storage in the lake could more effectively be used to reduce waste-water flow. Through more efficient use of delivered water, GID could save water both above and below J-Lake. Depending on the amount of storage provided, the project has the potential to save from 500 to 8,000 acre-feet of water annually at an estimated cost of up to $500,000 (Morrison-Maierle, Inc. 2011).

Construct re-regulating storage on Tank Coulee to reduce waste-water flows to Muddy Creek. Tank Coulee is another tributary to Muddy Creek on the East-Bench portion of GID. MSU (2006) has estimated that about 10,000 acre-feet of waste-water and irrigation return flow is lost down Tank Coulee during the irrigation season. This project would construct a new re-regulating reservoir on Tank Coulee to recapture flow off GID and minimize the return flow to Muddy Creek. This project would be operated in a similar manner to that described for J-Lake. It might be possible to save up to about 5,000 acre-feet of water annually with this project. The estimated cost might be $1,650,000 to $3,200,000 (Morrison-Maierle, Inc. 2011b).

Investigate Using in-canal storage on the GID Sun River Slope and Spring Valley canals: This option would use check structures and in-canal storage on the Sun River Slope and Spring Valley canals on the GID system to reduce operational spills from these canals. The project, as analyzed, was to upgrade two existing check structures, and to install two new ones. Because of the limited capacity to store water within the canal prisms, the total project only has the potential to supply benefits of about 250 acre-feet per year. Estimated construction costs are $1,600,000 (Morrison-Maierle, Inc. 2010).

Investigate the use of pump-back systems to reduce the flow of water from GID into Muddy Creek and other tributaries: There are a couple of existing systems on the eastern portion of GID that pump wastewater and return flow from drains and coulees back up into lateral ditches that are part of the GID water delivery system. These pumps capture and reuse water that otherwise would be lost from the system. Unfortunately, these pump-back systems are used infrequently because of the high power costs to operate them. This option would upgrade existing systems to more efficient variable-speed pumps, and also might include the installation of new pump-back systems. The option would possibly include the sharing of pump-back system operational costs, along with a sharing of benefits. Preliminary analyses indicate that pump-back systems might save about 1,000 acre-feet of water annually, per site. The project cost might be $50,000 to $100,000 per site (Morrison-Maierle, Inc. 2011b).

Install pressurized pipe to deliver water from the GID South Canal to the Simms area: An analysis of data collected by MSU (2007b and 2008b) and DNRC indicate that total water losses from return flow and waste-water to Big Coulee might average about 10,000 acre-feet of water per year. One way to reduce some of these losses would be to increase the efficiency of water deliveries from the main GID system to the lower Simms Bench area of the District. Currently, water is diverted from the GID South Canal into Big Coulee, and then re-diverted from Big Coulee further downstream into the Beale Canal to irrigate a 1,565-acre unit of GID in the Simms area. Inefficiencies in these water transfers can result in operational spills. This project would install a pipeline to convey water directly from the GID South Canal to the lower Simms Bench area. Because of the elevation drop from the South Canal to the lower bench, the project would also provide the benefit of water under pressure, which could be used to run sprinkler irrigation systems. It is estimated that the project would cost $3,500,000 and might save about 1,600 acre-feet of water annually (Morrison-Maierle, Inc. 2010b).

Install pressurized pipe to deliver water from the Mill Coulee Canal to the Ashuelot Bench: An analysis of flow data collected by DNRC indicate that from 6,000 to 9,000 acre-feet of return flow and wastewater flows back to the Sun River through Mill Coulee during the irrigation season. Most of this water originates from the Ashuelot Bench area of GID. This potential project would use pipe to deliver water under pressure from the Mill Coulee Canal to about 2,700 acres of irrigation on the Ashuelot Bench portion of GID. It would also include converting a substantial amount of flood irrigation to sprinkler systems. It is estimated that this project has the potential to save about 5,400 acre-feet annually and would cost about $7,500,000 (Morrison-Maierle, Inc. 2010b).

Replace Lateral ditches on the East Bench of GID with low-pressure pipelines: The majority of the water delivered to farm turnouts on the East Bench of GID is through lateral ditches which are unlined, or lined to a varying degree of effectiveness. Laterals could be replaced with low-pressure pipe, which might reduce seepage losses and improve delivery efficiencies. Using pipe could reduce operational spills that result when the ditches are run relatively full to ensure that enough water is available to the users at the very end of the ditch system. The benefits of using low-pressure pipe would depend on the lateral, likely would be relatively small for individual systems, but could provide significant cumulative benefits if many laterals were upgraded. Costs might range from $100,000 to $200,000 per system, and save from 100 to 200 acre-feet annually, per system (Morrison-Maierle, Inc. 2011b). Cumulatively, there is the potential for these types of projects to add up to a significant volume of saved water.

Rerouting and piping of the Fort Shaw Irrigation District C-K Canal: This project would re-route an inefficient and leaky portion of the FSID C-K Canal and replace a portion of the canal with PVC pipe. The project would save about 1,200 acre-feet of water annually. It would cost about $149,000 (TD&H, Inc. 2010). This will be accomplished by abandoning nearly 7,000 linear feet of a very leaky ditch, while maintaining service to existing irrigators using a series of pipeline drops from an upslope ditch.

Convert portions of the FSID l-4 and D-13 lateral systems to pipelines: This project would replace 4,860 feet of FSID ditches that have high rates of seepage with PVC pipe. This will be accomplished by replacing 4,860 feet of very leaky, open ditches with PVC pipe. It is anticipated that this project will save about 4,200 acre-feet annually. The estimated cost is $222,000 (Fort Shaw Irrigation District 2011).

Category 2: Reservoirs

There is a total of about 170,000 acre-feet of reservoir storage in the Sun River basin. For comparison, the average annual inflow to Gibson Reservoir is about 590,000 acre-feet. During most years, a substantial amount of the spring runoff water leaves the basin in a relatively short period of time because there is insufficient capacity and infrastructure to capture all of it. Reservoir projects could include the construction of new reservoirs, expansion of existing reservoirs, or changes in the operations or delivery of water to reservoirs. The following is a description of the reservoir projects that passed the Special Study initial screening.

Improve the Ability to divert water to Willow Creek Reservoir: Water is diverted from the Sun River to the Willow Creek Feeder Canal, which then flows into Willow Creek. From there, Willow Creek flows into Willow Creek Reservoir, where the water is captured and stored for later release back to the Sun River to meet peak irrigation demands. Because of problems with erosion on Willow Creek upstream of the reservoir, diversions of Sun River water into the reservoir feeder canal are limited to a rate of about 75 cfs. This constrains how fast the reservoir can be filled and can reduce the total capture of water during the brief period that water might be available for storage. If more water could be diverted to and stored in Willow Creek Reservoir during times of higher runoff, diversions could be reduced when less water is available and other demands are higher. Additional modeling would be needed to quantify the potential water savings benefits of this project. The most recent estimated cost estimate for stabilizing the Willow Creek channel, to allow for diversion rates of up to 300 cfs to Willow Creek Reservoir, was $1,700,000 (Land and Water Consulting, Inc. 1998).

Increase the storage capacity of Pishkun Reservoir: Pishkun Reservoir has an active storage capacity of about 30,686 acre-feet and is formed by eight earth-fill dikes with heights ranging from 10 to 50 feet and an overall length of 9,050 feet. There is no spillway for the reservoir and water is fed into the reservoir by the Pishkun supply canal. This option would increase the capacity of Pishkun Reservoir by raising the height of the dikes. Storage increases of 10,000, 16,000, and 26,000 acre-feet were examined (Reclamation 2010). Water rights associated with the expanded storage might be obtained by: 1) transferring rights associated with Gibson Reservoir that are now ineffective due to sedimentation to Pishkun Reservoir, and (2) a new water right for the storage of high spring flows that would be within the exceptions of the upper Missouri Basin closure (§85-2-343 MCA). The additional storage would provide a more reliable water supply for GID, which might in turn free up water that could be used to improve instream flow in the Sun River. The estimated cost is $29 million for a 26,000 acre-feet storage increase (TD&H, Inc. 2008b). Reclamation is still evaluating this alternative for safety of dams concerns and is scheduled to provide a report on the evaluation in 2012. However, this should be considered a screening-level evaluation only. Additional and extensive analysis and investigations would be necessary to advance this alternative further, if this initial evaluation were favorable. It should also be anticipated that extensive efforts will be required to evaluate potential environmental and cultural related concerns with enlarging the reservoir. An increased capacity at Pishkun Reservoir might have to be accompanied by an increase in the capacity of the supply canal, in order to take advantage of excess water to fill the reservoir which sometimes is only available during short windows of time.

Improve the Ability to divert water to Pishkun Reservoir: Although the capacity of the supply canal to Pishkun Reservoir generally is adequate, there are times when it may be advantageous to move water to Pishkun more quickly. This option would investigate that possibility. The canal has an existing capacity of approximately 1,400 cfs, and this capacity would need to be increased for the 12.1 miles of canal above Pishkun Reservoir. This project would need to be modeled through computer simulations of the system before an optimal canal size could be determined and before potential water savings benefits could be estimated. Potential costs for increasing the capacity of the supply canal have not been estimated.

Category 3: On-Farm Irrigation Efficiency Improvements

Possible on-farm efficiency improvements include conversion from flood to center-pivot sprinkler irrigation, better managing irrigation water by applying no more water than the crop needs, and converting on-farm open ditches to PVC pipe to reduce water loss. Although these types of projects could be undertaken by individual operators, larger, coordinated projects would be needed to accumulate measurable savings where a portion might be used to improve stream flows. The Ashuelot Bench and Simms area projects, described in the Delivery System Improvements section, include improved on-farm efficiency components. No other project blocks have been identified at this time.

Category 4: Other Water Management Measures

Investigate the costs and benefits of purchasing or leasing senior water rights and changing them to instream flow use: This option would investigate potential benefits and opportunities for purchasing existing irrigation water rights and changing the use to instream flow. Instead of being diverted for irrigation use, the water for these transferred rights would be left in the Sun River to provide instream-flow benefits. This type of transfer would need to be negotiated by willing sellers and buyers. The option most likely would involve leasing water rights for instream flow, rather than a permanent water rights change. The costs of water would need to be determined between buyer and seller and would vary based on market conditions. For Montana instream flow leases that TU was involved with, costs were $21 to $25 per acre-foot (Ziemer, 2011). Although the Sun River Watershed Group would not actively pursue such purchases and changes, it might be able to offer assistance to willing buyers and sellers to ensure that transfer goals are realized without impact to other water users.

Evaluation of Screened Alternatives

The potential projects that passed the initial screening were incorporated into an evaluation spreadsheet. The spreadsheet included the initial screening criteria and other criteria to assess costs, and potential water savings. The spreadsheet can be found in Appendix A.

The first set of screening criteria in the spreadsheet, beyond the preliminary screening criteria, is an estimate of the amount of water that the alternative might save. These savings are tabulated as an annual volume in acre-feet. The next criteria addressed was where in the river system might some of the saved water provide instream-flow benefits. Projects also were examined as to whether or not they might provide benefits both to irrigation and instream flow purposes. Estimates of project costs also were developed. This included total costs to build or implement the project, annual cost, and cost per unit of water saved in acre-feet. For some projects, where costs were very uncertain due to limited information for analysis, a max-min cost range was used. Alternatives also were assessed for their potential complexity, from an administrative, legal and permitting standpoint. Additional studies that would be required before a project could be constructed or implemented were identified and listed too. And an estimate was made of the time it might take to implement the project. Agencies and groups that might be involved in development of the alternative were identified. Finally, a judgement was made on what the potential was to obtain funding for the project, from grants and other sources.

After considering all of this information, the final selected projects were compared and ranked. This ranking did not strictly order the projects from highest to lowest, but partitioned projects which were considered to have the most potential into three groups based on when it might realistically be possible to implement the projects. Group 1 projects were those that ranked high and which the group could pursue now or in the near future. The second group of potential projects consisted of those which the group considered to be good projects overall, but where there was a lot more work to be done before the projects could be implemented. The third group consisted of projects that might have some potential, but were complex, possibly expensive for the benefits that could be realized, and not workable at this time………but to still consider during future planning. A final fourth group contains projects that were dropped from further consideration at this point in the project screening.

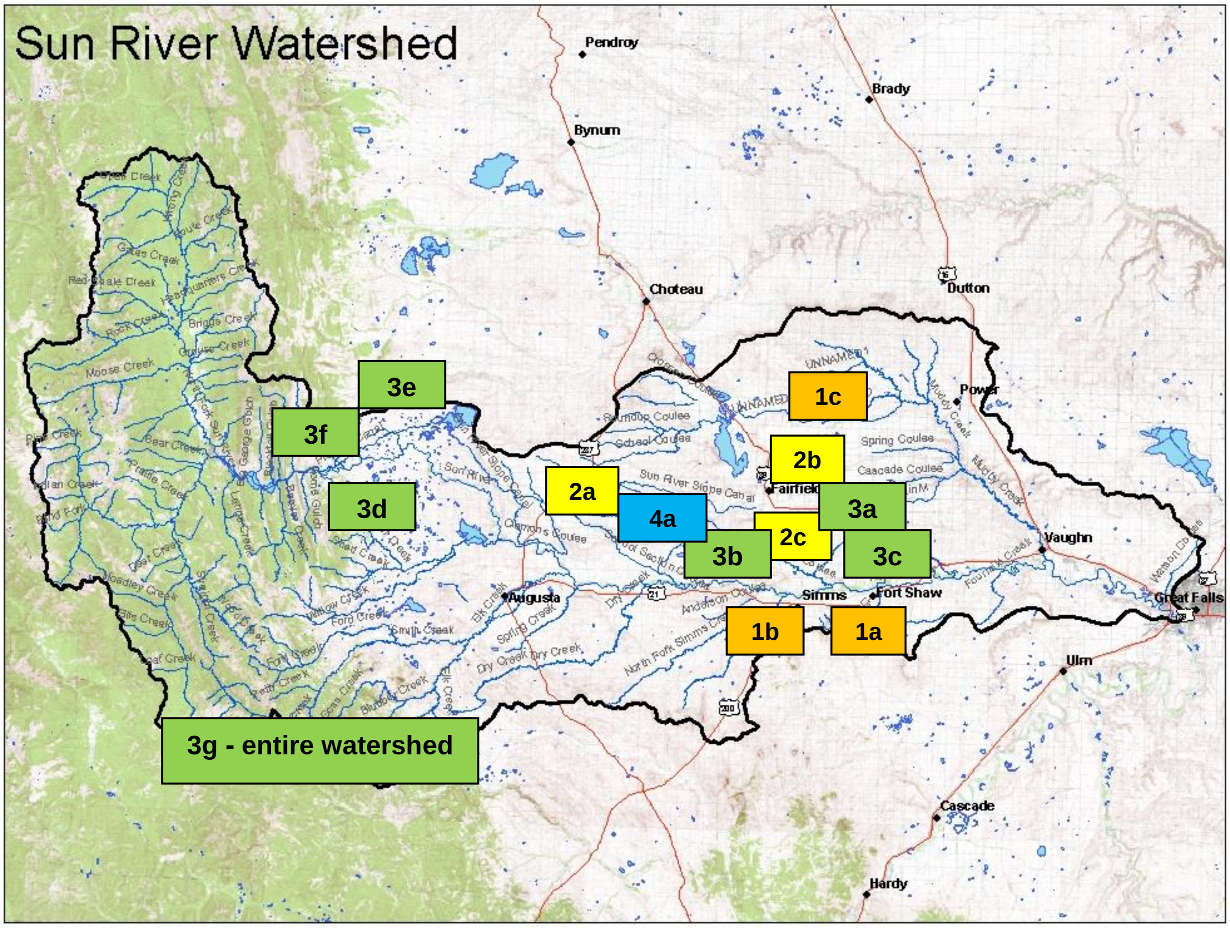
Selected Projects by Group

Table 5 lists projects that the group believes have potential, and that it would like to pursue further. The exception is the Group 4 project, which was found to have a low potential to provide substantial water-savings benefits. The project groups are ordered by the amount of time it might actually take to implement the projects. Map 2 shows the location of the projects within the Sun River watershed. All of the costs listed in Table 5 are preliminary.

Table 5. Selected Projects by Group.

Group 1: Projects with good potential that the SRWG should work towards implementing in the short term		
Project Description	*Estimated Time to Implementation*	*Estimated Cost*
FSID C-K pipeline	Project construction completed	$149,000
FSID L4 and D13 pipelines	Ongoing: 1 year to completion	$222,000
GID pump-back systems	May involve multiple projects over a period of 1-to-5 years	$50,000 to $100,000 per system
Group 2: Projects for the SRWG to work towards in the medium term where more detailed analysis is needed and which would require more substantial funding		
Project Description	*Estimated Time to Implementation*	*Estimated Cost*
Sunny Slope canal lining	5-to-10 years	$3,000,000
J-Lake re-regulating storage	5-to-10 years	$500,000
Ashuelot Bench pressurized pipe and improved efficiencies	5-to-10 years	$7,5000,000
Group 3: Projects for SRWG to continue to investigate for long-term planning; these projects may be expensive or require substantial coordination and funding		
Project Description	*Estimated Time to Implementation*	*Estimated Cost*
Tank Coulee re-regulating storage	10-to-20 years	$1,650,000 - $3,200,000
Pressurized pipe to Simms area with improved efficiencies	10-to-20 years	$3,500,000
GID low pressure pipe delivery system projects	10-to-20 years	$100,000 - $200,000 per system
Willow Creek Reservoir flow delivery rate increase	10-to-20 years	$1,700,000
Pishkun Reservoir Enlargement	5-to-10 years	$29,000,000
Pishkun Reservoir flow delivery increase	10-to-20 years	Not available
Water rights changes to instream flow purposes	10-to-20 years	$20 per acre-foot or more
Group 4: Project that are currently considered to have a low potential for providing benefits		
Project Description	*Estimated Time to Implementation*	*Estimated Cost*
In-canal check structures	None	$1,600,000

Map 2. Special Study Potential Projects Location Map.



Group 1

- 1a. FSID C-K Pipeline
- 1b. FSID L4 & D13 Pipelines
- 1c. GID Pump-back Systems

Group 2

- 2a. GID Canal Lining
- 2b. GID J-Lake
- 2c. GID Ashuelot Bench

Group 3

- 3a. GID Tank Coulee
- 3b. GID Simms Area
- 3c. GID Low Pressure Pipe
- 3d. GID Willow Creek
- 3e. GID Pishkun Enlargement
- 3f. GID Pishkun Delivery
- 3g. Watershed Water Rights

Group 4

- 4a. GID In-Canal Checks

IMPLEMENTATION PLAN

This section outlines a plan for further evaluating and implementing the projects that have potential to save water and provide shared benefits to agriculture and instream flow. Basic procedures that might be followed, from feasibility studies through project construction, are discussed. Because every project is different, this implementation plan is general rather than project specific. An important component of any project selected would be to develop a plan for sharing the saved water between irrigation and instream uses. Following the general implementation plan discussions is a specific example of an ongoing project that is being implemented under the Special Study framework.

Project Evaluation

Many of the projects discussed in this report have been evaluated at the conceptual level because only enough information has been assembled on the project to determine if it might be workable, and to develop a rough estimate of project costs and water-saving potential. Costs estimates in this report might be, at best, within about 25 percent of actual 2012 costs.

Projects that the Watershed Group intends to proceed with would need to be brought from the conceptual design level to the feasibility level. This would include a more detailed engineering evaluation of project components, and a more detailed estimate of project capital costs, as well as operation and maintenance costs. A more thorough evaluation of the water-savings potential of the project also would be required. This might include on-site evaluations during the irrigation season to determine flow conditions at the project site and to evaluate water-savings potential under a variety of conditions. The details collected during this stage of the project evaluation could be used to make a final decision on whether it would be worth pursuing the project.

Projects that the group chooses to proceed with, and which there is funding for, would continue to final design and through all appropriate environmental compliance and permitting activities. This would be the level of design required before construction could proceed. The final design will contain a much more refined estimate of project costs.

Developing a Methodology for Allocating Saved Water

The overall purpose of the Special Study is to identify water conservation projects that have the potential to improve agricultural productivity and enhance streamflow in the Sun River. In the past, a number of water conservation projects have been implemented in the watershed. Many of these projects have been successful in improving crop production and in decreasing return-flow water to lower Sun River tributaries, such as Muddy Creek, Mill Coulee (photo 3), and Big Coulee, but they haven't necessarily resulted in improvements in flow to the reaches of the Sun River where flow is most critically needed. The reason for this is that, during most years, there are irrigation water shortages and the water that is conserved is simply re-distributed and used by irrigators to decrease crop-water shortages.

Photo 3. Return and waste-water flow in Mill Coulee.

Part of the plan for the Special Study was to develop methodologies for sharing the benefits of saved water between instream and agricultural uses. An underlying principle to this sharing of benefits is the sharing in the responsibility to procure funds to implement the projects that result in water savings. Although the specifics of how benefits are to be shared would vary from project to project, a general agreement among participants is that water savings will be shared equitably between irrigation and instream uses. Agreements also likely will have adaptive management stipulations for sharing the pain when unusual conditions occur, for instance, during extremely dry years. Water-sharing agreements could be entered into between irrigation districts and other irrigation water rights holders, and entities that represent instream flow interests, such as FWP and TU.

Binding agreements as well as cooperative relationships would need to be established between project partners to ensure that the benefits of water conservation projects are shared as intended. Agreements might need to specify how the project is to be paid for and by whom, who will be responsible for operating and maintaining the projects and associated costs, how water savings will be tallied, and how the water savings allocated to instream flow will be realized in the river, and when and where. Because there is not a lot of precedent in Montana for these types of agreements, parties will need to be creative and flexible. After an initial agreement is made for one project identified in the Special Study, it could be useful as a template on which subsequent projects can build. A potential outline of what this type of agreement might look like is attached in Appendix D.

Operation and Maintenance of Projects

Most projects, once they are constructed, will need to be operated and require periodic maintenance. There also will be annual costs for operating some projects, such as the power costs to operate pump-back systems. During project planning these costs will need to be recognized and factored into funding. Water-sharing agreements might contain stipulations as to which parties are responsible for operation and maintenance costs.

Obtaining Project Funding

It is likely that the costs of most projects will be beyond the capacity of what any single user will be able to pay for. Because the projects will provide shared benefits, the Sun River Watershed Group will work with the project beneficiaries to obtain project funding. Funding might come from a combination of government and private sources. For feasibility level studies, project planning grants might be obtained through the DNRC Renewable Resource Project Planning Grants program. DNRC Renewable Resource Grants and Renewable Resource Loans might be a source for funds for implementation of small to mid-sized projects. Other potential grant sources include Reclamation's WaterSMART, FWP Future Fisheries, and NRCS programs such as EQIP (environmental quality incentive program), and AWEP (agricultural water enhancement program).

Irrigation Districts might be able to provide in-kind construction and other services to match the funds provided by grants and other sources. GID, for example, has substantial construction capabilities and has demonstrated its expertise by completing a number of large infrastructure projects. Using these resources could result in substantial savings on project construction costs.

Example Project: Convert Portions of the FSID L-4 and D-13 Lateral Systems to Pipelines

Project History and Evaluation

The Fort Shaw Irrigation District had been working with the Sun River Watershed Group for 15 years to conserve water for the benefit of all users while at the same time improving their ability to deliver water to District producers. Over the years, FSID had implemented a variety of infrastructure improvements but was finding, through experience, that projects which converted open ditch delivery systems to pipelines were producing the most benefit. These types of projects are logical choices for the District to pursue because estimated conveyance efficiencies of the open ditches on FSID were found to be only about 46 percent (Reclamation, 1982). After assessing the system as a whole, FSID and the SRWG targeted the L and the D system ditches as a top priority for future improvement. While the Special Study was in progress, the FSID and SRWG pursued an available opportunity to fund and implement this project.

Obtaining Project Funding

With the assistance of the SRWG, FSID submitted an application to Reclamation under the WaterSMART program. The District requested funding to replace 4,860 feet of very leaky open ditches with PVC pipe. It was estimated that improvements to these delivery systems would result in water savings of 4,158 acre-feet per year. The estimated total project costs were $222,367, of which a grant from Reclamation of $103,717 was requested with the balance to be contributed through labor, equipment and in-kind services by FSID and SRWG. An important component of the grant application was a commitment to improve Sun River flows below the FSID Diversion Dam during the summer irrigation season. Reclamation funded the project for the amount requested.

Project Implementation

Upon receiving project funding, FSID and SRWG worked with Reclamation on National Environmental Policy Act (NEPA) and National Historic Preservation Act (NHPA) compliance, and on obtaining the permits needed before construction could proceed. This included the Corps 404, Cascade Conservation District 310 and DEQ 3A Turbidity permits, and a permit for access across County roads. FSID used a portion of the funds to hire an engineering firm for assistance with project design and construction oversight. Work on the project began during the fall of 2011 and construction work proceeded on schedule, with the project mostly complete by the early spring, 2012. This included replacement of the leaky ditches with PVC pipe, and improvements to headgates and farm turn-outs.

Project Follow-Through and Performance Measures

With the assistance of SRWG, FSID has committed to measuring water delivered to the farms on the ditch system, and to measure return flows in Adobe Creek and flows in the Sun River at Simms for two years following project completion. These flows will be compared to corresponding flow data prior to the system improvements in order to document water savings due to the project. Flow monitoring efforts might continue following the 2-year period, if resources are available.

Developing and Implementing a Plan for Sharing Water Savings

FSID has committed to sharing water savings resulting from this project by increasing Sun River flows by 10 CFS at the USGS gaging station near Simms during the summer irrigation season. FSID is working with TU on this plan, with assistance from the SRWG. An important consideration towards the success of this plan will be adequate communication with other water users on the river to ensure that the targeted flows remain in the river. Although the 10 CFS may not seem huge, it represents a significant improvement to this reach of the river, where irrigation-season flows drop to as low as 30 CFS.

CONCLUSIONS

The Sun River Watershed Group and others have been working to improve flows in the Sun River while maintaining or improving the production of irrigated agriculture. Because water is not always available in the amounts required to meet all uses, improving Sun River flows has been a persistent challenge. The Watershed Group has found that no one project by itself will solve all of the low-flow problems in the Sun River. This Special Study has identified a number of projects that have the potential to conserve water, and provide shared benefits to irrigators and instream flow in the Sun River. Taken together, these projects might be enough to produce shared benefits and to increase Sun River instream flows at key locations, and during critical times.

Implementing these projects will require a commitment from group members and working together as a team to obtain the necessary funding for design, authorization, and construction. Continued success of the project will require follow-through with operation and maintenance long after the projects are constructed. Developing agreements among parties that allow for sharing a project's water-saving benefits between irrigation and instream uses is critical to the success of these projects, and for achieving the goals of the Special Study.

The Special Study maps out a path for achieving these goals. The process that the group sets out should be flexible too, so that other water-conservation projects that might be identified can be incorporated in the future into the framework set forth in the Special Study.

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Appendix A: Project Review Spreadsheet Matrix

Appendix A: Project Review Spreadsheet Matrix View 1.

	Potential projects were screened for the following initial criteria				Water Saved (Acre-ft)		
	Does the project have the potential to provide water for irrigation and/or instream flows?	Does the project have the potential to adversely affect water users and/or instream flows?	Are there insurmountable hurdles?	Does the project pass the initial screening or can the project be adjusted to pass? If yes, continue. If no, remove from consideration in the Special Study	Winter	Summer	River Reach / Canal Location where saved water can be realized
Category 1 - Delivery Systems							
Investigate the potential for water savings of lining up to 3 miles of the Sunny Slope canal near Augusta.	Yes	There are possible effects to how water in the reach between upstream of the Ft. Shaw Diversion Dam is managed between GID, Fort Shaw, and Broken O.	No	Project passes the initial screening	0	10,000 to 12,000 acre-feet	Sun River Diversion Dam to mouth *
Investigate using J-Lake re-regulating storage to help reduce waste water flow to Muddy Creek.	Yes	Waste-water flows in Spring Coulee would be reduced. This could affect users who pump water from that source.	No	Project passes the initial screening	0	Potential of 500-8,000 depending on size of storage	Sun River Diversion Dam to mouth *
Investigate using Tank Coulee re-regulating storage to help reduce waste water flow to Muddy Creek.	Yes	Waste-water flows in Tank Coulee would be reduced. This could affect users who pump water from that source.	No	Project passes the initial screening	0	Up to 5,000 acre-feet dependent on reservoir size	Sun River Diversion Dam to mouth *
Investigate using check structures and automation to provide in-canal storage to help reduce waste water flows into Big Coulee, Muddy Creek and other drains.	No	No	No	No due to low water-savings potential	0	248 acre-feet	Sun River Diversion Dam to mouth *
Investigate pump back sites on GID's system in order to reduce flows into Muddy Creek and other tributaries.	Yes	Waste-water flows into Muddy Creek and its tributaries would be reduced. This could affect users who pump water from those sources.	No	Project passes the initial screening	0	Possibly 1,000 acre-feet per site	Sun River Diversion Dam to mouth *
Investigate installing pressurized pipe to deliver water from the GID South Canal to the Simms area and converting some flood irrigated acres to sprinkler irrigation.	Yes	No	No	Project passes the initial screening	0	About 1,600 acre-feet	Sun River Diversion Dam to mouth *
Investigate installing pressurized pipe to deliver water from the Mill Coulee Canal to the Ashuelot Bench area and converting some flood irrigated acres to sprinkler irrigation.	Yes	No	No	Project passes the initial screening	0	About 5,400 acre-feet	Sun River Diversion Dam to mouth *
Replacing lateral ditches on the East Bench of GID with low-pressure pipe (GM 100-8).	Yes	Waste-water flows into Muddy Creek and its tributaries would be reduced. This could affect users who pump water from those	No	Project passes the initial screening	0	100 to 200 acre-feet per site	Sun River Diversion Dam to mouth *
Investigate reducing waste from FSID C-K canal through a combination of piping and rerouting canal.	Yes	No	No	Project passes the initial screening	0	About 1,200 acre-feet	Sun River Downstream of Fort Shaw Irrigation District Diversion Dam
Investigate reducing waste to Adobe Creek from FSID L-4 and D-13 system through piping.	Yes	No	No	Project passes the initial screening	0	About 4,200 acre-feet	Sun River Downstream of Fort Shaw Irrigation District Diversion Dam
Category 2 - Reservoirs							
Increase the rate at which water can be delivered to Willow Creek Reservoir	Yes	More water would be diverted from the Sun River at times. Diversions would need to occur when prior rights would not be adversely affected.	No	Project passes the initial screening, but landowner concerns with channel erosion would need to be resolved		Not Available	Sun River Diversion Dam to mouth *
Increase the rate at which water can be delivered to Pishkun Reservoir	Yes	More water would be diverted from the Sun River at times. Diversions would need to occur when prior rights would not be adversely affected.	No	Project passes the initial screening		Not Available	Sun River Diversion Dam to mouth *
Increase the height of the Pishkun Dikes to increase the storage of Pishkun Reservoir	Yes	More water would be diverted from the Sun River at times. Diversions would need to occur when prior rights would not be adversely affected.	No	Project passes the initial screening		10,000 to 26,000 acre-feet	Sun River Diversion Dam to mouth *
Category 3 - On Farm							
Category 4 - Miscellaneous Water Management Measures							
Investigate cost/benefit of buying out senior water rights and changing the use to instream	Yes	No	No	Project passes the initial screening	Would depends on change	Would depend on water right change	From existing Water Right point of diversion location to Mouth

Note: For purposes of the Sun River Special Study, the term 'water saved' refers to the recovery of water intended for a specific use that leaves the system (reservoir, canal, lateral, etc.) without fulfilling the intended function of that use. Examples of loss include (but are not limited to) seepage, evaporation, evapotranspiration, and unrecovered water that enters an irrigation system's 'waste' system.

* Water savings for these projects could decrease the amount of water that needed to be diverted from the Sun River at the Diversion Dam during times of low flow

Appendix A: Project Review Spreadsheet View 2

Investigate the potential for water savings of lining up to 3 miles of the Sunny Slope canal near Augusta.	$3,000,000	$250 to $300								Moderate	High	Moderate	Would require engineering design work	GID may be able to install liner	5 to 10 years
Investigate using J-Lake re-regulating storage to help reduce waste water flow to Muddy Creek.	$470,000 for larger reservoir	$50 to $1,000	$20,038	$20,038	$40	$3	$730	$42	$3	Moderate	Moderate	Moderate	Feasibility study and Final Design	GID could do much of the construction work	5 to 10 years
Investigate using Tank Coulee re-regulating storage to help reduce waste water flow to Muddy Creek.	$1,650,000 to $3,200,000	$330 to $640	$136,428	$70,346	$27	$14	$730	$27	$14	Moderate	Moderate	Moderate	Feasibility study and Final Design	GID could do much of the construction work	10 to 20 years
Investigate using check structures and automation to provide in-canal storage to help reduce waste water flows into Big Coulee, Muddy Creek and other drains.	$1,600,000	$6,500	$68,214	-	$275	-	$2,300	$284	-	Moderate	Moderate	Moderate	Feasibility studies and Final Design	GID could do much of the construction work	Implementation is not recommended
Investigate pump back sites on GID's system in order to reduce flows into Muddy Creek and other tributaries.	$50,000 to $100,000 per site	$60 to $100	$4,263	$2,132	$4	$2	$740	$5	$3	Low	Low	Low	Additional sites for pump-back systems need to be located. Designs for each	GID could do installation work	1 to 5 years
Investigate installing pressurized pipe to deliver water from the GID South Canal to the Simms area and converting some flood irrigated acres to sprinkler irrigation.	$3,500,000	$2,100	$149,218	-	$93	-	$980	$94	-	Moderate	Moderate	Moderate	Feasibility studies and Final Design	GID could do much of the pipe installation	10 to 20 years
Investigate installing pressurized pipe to deliver water from the Mill Coulee Canal to the Ashuelot Bench area and converting some flood irrigated acres to sprinkler irrigation.	$7,500,000	$950	$319,753	-	$59	-	$980	$59	-	Moderate	Moderate	Moderate	Feasibility studies and Final Design	GID could do much of the pipe installation	5 to 10 years
Replacing lateral ditches on the East Bench of GID with low-pressure pipe (GM 100-8).	$121,000	$700	$5,163	-	$30	-	$260	$31	-	Low	Low	Low	Feasibility studies and Final Design	GID could do much of the pipe installation	10 to 20 years
Investigate reducing waste from FSID C-K canal through a combination of piping and rerouting canal.	$149,000	$124	$6,352	-	$5	-	$800	$6	-	Low	Moderate	Moderate	Project is Complete	FSID provided construction assistance	Construction Completed
Investigate reducing waste to Adobe Creek from FSID L-4 and D-13 system through piping.	$136,000	$32	$5,798	-	$1	-	$1,000	$2	-	Low	Moderate	Moderate	Project is to Construction Phase	FSID will provide construction assistance	1 year

Category 2 - Reservoirs

Increase the rate at which water can be delivered to Willow Creek Reservoir	$1,700,000									Moderate	Moderate	Moderate	Feasibility studies and Final Design	GID could do much of the bank stabililzation construction	10 to 20 years
Increase the rate at which water can be delivered to Pishkun Reservoir	Not available									Moderate	Moderate	Moderate	Feasibility studies and Final Design	GID could do much of the canal enlargement construction	10 to 20 years
Increase the height of the Pishkun Dikes to increase the storage of Pishkun Reservoir	$29,000,000	$1,100								Moderate	Moderate	High	Feasibility studies and Final Design	GID could do much of the required earthwork	5 to 10 years

Category 3 - On Farm

Category 4 - Miscellaneous Water Management Measures

Investigate cost/benefit of buying out senior water rights and changing the use to instream		$21 to $25								Low	High	High	Legal work and assessments	TU, DNRC and others can do permitting, legal and feasibility	1-2 years for study and permitting

Note: For purposes of the Sun River Special Study, the term 'water saved' refers to the recovery of water intended for a specific use that leaves the system (reservoir, canal, lateral, etc.) without fulfilling the intended function of that use. Examples of loss include (but are not limited to) seepage, evaporation, evapotranspiration, and unrecovered water that enters an irrigation system's 'waste' system.

* Water savings for these projects could decrease the amount of water that needed to be diverted from the Sun River at the Diversion Dam during times of low flow

Appendix B: Options Identified During Brainstorming that did not fit in the Special Study

These options were dropped from further consideration in the Special Study. There may be opportunity to improve water management in the watershed with these options, but they are outside of the scope of what is needed or could be analyzed in the Special Study at this time.

1. Review natural Willow Creek inflows to determine if they are declining and why.
It would be interesting to find out if Willow Creek natural flows are declining, but it is unlikely there is anything that could be done if they are.

2. Investigate minimum flows and flow gains in the Sun River below the Fort Shaw diversion.
We already compiled a lot of information on this with the stream gaging and synoptic measurements. This seems to be more a question of how other alternatives might affect gains and losses, rather than an option in itself.

3. Review winter release rates.
This already has been done.

4. Use the internet to track all water diverted to help manage water better.
This is an ongoing effort. It seems that with the Hydromet system, USGS gages, and the District's resources water is being tracked pretty well.

5. Look at impacts of changing water use from Ag to other uses, such as pond or yards.
This really is not an option for improving instream flows in the Sun River. These sorts of changes are occurring, but our intuitions are that they are only a small part of the total water use.

6. Improve the accuracy of the measurement of water over the Diversion Dam.
This is an ongoing task; it probably doesn't need to be explicitly addressed as an option in the Special Study.

7. Add more SNOTEL sites in the watershed.
This would be helpful, but it would be difficult to quantify the potential water savings.

8. Cleanup streamflow data to make it more accurate and usable.
This is a long-term goal, but not a Special Study Alternative.

9. Trans-basin transfer.
Not lots of possibilities here because all the surrounding watersheds on the east-side of the Divide are water short too, and any water transfers from the west-side would have to occur through a remote wilderness area.

10. Investigate cloud seeding.
It doesn't seem to have a lot of potential because of state and federal laws and policies.

11. Review the work done by other watershed groups for other ideas on water conservation: Specifically mentioned the review of work done by the Jefferson Watershed Group.
Work and projects done by other groups was taken into consideration in developing potential projects.

Appendix C
Instream Flow Pursuit Sideboards

Finalized at December 10, 2008 meeting

CONDITION
Be above board on all acceptable solutions
Projects and solutions should provide true "win-win" results
Realize there is a risk factor with any changes
Projects shall provide 1ransparency and accountability to all project partners
Projects shall provide benefits to as many watershed group members as possible and will not adversely affect the interest of any member
Projects shall conform to Reclamation and state water laws, including evaluation of return flow issues and adverse impacts to third-party water right holders (ie. PPL)
Need to look at "big picture" with all projects
Water savings from projects should be shared fairly and equitably
With any water savings, need to decide if will be divided up by percentage or at a variable rate
Projects will strive to find and provide 100 cfs out of Gibson to meet the 130 cfs FWP instream flow right from Elk Creek to confluence with Missouri River
Need to seriously evaluate all risks when swapping water for money
Trying to meet agriculture needs at the headgate while looking at opportunities to use saved waste-water to help increase river flows
Need to consider impacts to return flows with any project
Mechanism to deal with individual farmers risk when pursuing Gibson storage issues
If increase storage is pursued, need to look at adverse effects to other water needs
Allow capture for filling reservoirs during runoff periods
Full reservoirs does not guarantee full water season
Need operations review for water savings improvements then rank projects

First criteria established were:

- Project will help irrigation
- Project will benefit the river
- Project will make up for lost reservoir capacity at Gibson
- Project cost will be considered
- Project feasibility to be considered
- Does the project have an adverse impact on other water users
- Project needs to consider actual water saved
- Does the project fit legal and permitting requirements
- How complex is the project
- Location on where the water savings benefits will occur
- Water savings timing and return flow impacts
- Include life-span of the potential projects and the average annual costs for the life of each project

Appendix D: Basic Water-Sharing Agreement Outline

MEMORANDUM OF UNDERSTANDING

AMONG

______(entity saving water)_________
SUN RIVER WATERSHED GROUP
TROUT UNLIMITED
MONTANA DEPARTMENT OF FISH, WILDLIFE, AND PARKS
and the
U.S. DEPARTMENT OF INTERIOR, BUREAU OF RECLAMATION, GREAT PLAINS REGION,
MONTANA AREA OFFICE.

DATED THIS _____ DAY OF ______________, 2012.

This Memorandum of Understanding (MOU) is among the _____________________, the Sun River Watershed Group, Trout Unlimited, and the Montana Department of Fish, Wildlife, and Parks, and the United States Bureau of Reclamation. The purpose of this MOU is to allocate the conserved water from a collaborative water conservation project between irrigation and instream purposes.

I. Background.

The signatories to this MOU have all, through lengthy involvement, discussion, fundraising, and work, participated in the collaborative water conservation project to ____(project name).

The objective of this project is to ______________________(description of the project).

______ (project information)

II. Objectives.

The signatories to this MOU agree that the following principles are guiding their allocation of conserved water from the collaborative water savings project:

- **Proportional Investment.** Conserved water is allocated in roughly equal measure between irrigation and instream flows because each interest has, and will, invested time, involvement, and has made contributions to the overall success of the project.

- **Fairness.** Conserved water is allocated between irrigation and instream flows to meet the needs of each interest, to the greatest possible extent.

- **Adaptive Management.** While the signatories to this MOU have worked for several years to quantify the water loss, we acknowledge that these are still estimates. The signatories to this MOU acknowledge that as additional data is collected over time after the project is completed, the signatories will re-evaluate the implementation of the water savings agreement according to the two principles articulated above, fairness and proportional investment.

III. Allocation of Water Savings.

The signatories to this MOU agree to allocate the water savings from the collaborative ___(project name)____ fairly between irrigation and instream flow needs, based on: on-going monitoring of conserved water; adaptive management and learning from successive years of implementation; wet-year management; and, dry-year management. This MOU addresses utilization and allocation of water conserved through __(project activitiy)__ and assumes all other water management operations remain similar to historic methods of operation.

IV. Implementation of Water Savings Agreement.

The signatories to this MOU propose to administer the water conserved from the ___(project name)_________ as described herein, as follows:

1. For the life of the project, at least one-half of the estimated annual conserved volume of water will be administered by the _____(entity saving water)________, to deliver to its share-holders as needed to meet the District's water delivery obligations for an irrigation purpose. More than one-half of the annual conserved volume of water will be administered for an irrigation purpose under drought conditions, pursuant to the "Dry-Year Administration" paragraph, below.

2. For the life of the project, one-half of the estimated annual conserved volume of water will be administered by the _____(entity saving water)________, in collaboration with Trout Unlimited and the Sun River Watershed Group, for an instream purpose, subject to reduction pursuant to the "Dry-Year Administration" paragraph, below.

3. Allocation of the conserved water for an instream purpose will take place when the Sun River Watershed Group and Trout Unlimited request that the _____(entity saving water)________, deliver water over Diversion Dam. The period of delivery will be restricted to between July 15 and September 30 annually, and requests for an instream delivery will be triggered by Sun River flows between 130 cfs and 40 cfs as measured at the Simms USGS gauge. _____(entity saving water)________, will deliver water over Diversion Dam for an instream purpose up to the volume cap identified below, in the Wet-Year and Dry-Year Administration paragraphs, in consultation with the Sun River Watershed Group and Trout Unlimited. Delivery of the conserved water for an instream purpose down to the Simms USGS gauge will be accomplished pursuant to a water administration agreement, separate from and involving parties not included in this MOU. That separate water administration agreement will conform to Mont. Code Ann. § 85-2-411 ("Water turned into natural channels").

4. Upon reaching the end of the life of the project, or its earlier termination, Trout Unlimited and the Sun River Watershed Group shall terminate and surrender to _____(entity saving water)________, and the _____(entity saving water)________, the conserved water dedicated to instream flows, unless otherwise agreed to by the parties.

5. The parties acknowledge that there is no intent to abandon any portion of the conserved water, nor does this MOU imply any relinquishment of the ownership rights of the _____(entity saving water)________, or the _____(entity saving water)________, over any of the conserved water, whether it is put to an instream or irrigation purpose.

V. Monitoring and Administration of Conserved Water.

1. Monitoring of Loss. Describe monitoring

2. Wet-Year Administration. The parties to this MOU agree to a protocol for administration of conserved water in an average to wet-year, based on one-half of the estimated volume of conserved water delivered over Diversion Dam. The determination of an average to wet-year will be made in the spring of each year, based on whether Gibson Resevoir fills. If Gibson Reservoir fills, defined for purposes of this MOU as reaching a minimum of 96,500 acre-feet of storage, then the Sun River Watershed Group and Trout Unlimited may request delivery over Diversion Dam of flows between July 15 and September 30 of each year hereunder, not to exceed one-half of the estimated volume of conserved water.

3. Dry-Year Administration. The parties to this MOU agree to a protocol for administration of conserved water in dry years and drought years. The determination of a dry or drought year will be made in the spring of each year based on whether Gibson Reservoir fills, reaching 96,500 acre-feet of storage. If Gibson Reservoir does not fill in a dry or drought year, then the percentage by which Gibson Reservoir fails to fill (the percentage less than 96,500 acre-feet of storage reached as measured on the date of the first releases of stored water) will be the percentage reduction in the volume of water that the Sun River Watershed Group and Trout Unlimited may request for delivery over Diversion Dam.

4. On-Going Monitoring. The parties to this MOU agree that on-going monitoring of canal loss, water deliveries, and implementation of this MOU is necessary for its long-term success. Pursuant to the adaptive management principle set out in Section II of this agreement, the data collected from on-going monitoring will provide the basis for any future revision to the estimated volume of conserved water, or other amendment to this agreement, based on the written consent of all arties hereto.

VI. Agreement in Good Faith.

The parties to this MOU have worked in good faith to come to an agreement, and will continue to work in good faith to implement this water allocation agreement. No party to this MOU shall unreasonably withhold consent to alter its terms in the future, based on the results of the on-going monitoring and the shared learning during its implementation.

Signed this ________ day of ___________________, 2012.

________________________________ ________________________________

_____(entity saving water)________, Sun River Watershed Group

________________________________ ________________________________

Trout Unlimited

Montana Dep't of Fish, Wildlife and Parks

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Bureau of Reclamation
United States Department of Interior