Technical Memorandum 2.5
Case Studies

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ECONorthwest specializes in the economic and financial analysis of public policy. ECO has analyzed the economics of resource-management, land-use development, and growth-management issues for municipalities, state and federal agencies, and private clients for more than 30 years.

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I. INTRODUCTION AND BACKGROUND

Other Technical Memoranda in this project provide an overview of the irrigation systems throughout Montana (*Technical Memorandum 1.3)*, and detail the availability of land and water resources for irrigation throughout Montana (*Technical Memorandum 1.2/1.4)*. They also provide a conceptual framework for understanding the relationship between irrigation and Montana's economy (*Technical Memorandum 2.1)*, and explore the net economic benefits *(Technical Memorandum 2.2)* and net economic impacts *(Technical Memorandum 2.3)* of irrigation in Montana, focusing broadly on the state as a whole. This Technical Memorandum allows us apply the concepts presented throughout these other Technical Memoranda to four specific regions of Montana where irrigated agriculture plays an important role in the economy.

The four case studies presented in the following pages are:

1. Greenfields Irrigation District. This case study describes the net economic benefits and impacts associated with what is often held as an example of one of Montana's most well-managed, robust irrigation districts.

2. Irrigation in the Bitterroot Valley. This case study focuses on the impacts to irrigated agriculture that arise from an economy in transition, moving from a historical emphasis on agriculture and natural-resource-extraction industries, to a growing emphasis on amenities and recreational opportunities, spurring rapid population growth and suburban encroachment on agricultural land.

3. Milk River Irrigation Project. This case study illustrates the relationship between irrigated agriculture and the many ancillary issues that materialize when municipal, industrial, recreational, and other demands for water are dependent on irrigation infrastructure.

4. Irrigation in the Lower Yellowstone and Lower Missouri River Valleys. These two, combined case studies describe the net economic benefits and impacts of irrigation in a region where access to land and water for irrigation is readily available, and where there are limited competing demands for water-related goods and services.

We selected this set of case studies with input from Chad Lee, Tim Bryggman, Pat Riley, and Alice Stanley, to illustrate the wide range of issues faced by irrigators across the state of Montana, and to explore the effects of potential investments in irrigation in each disparate setting. The case studies demonstrate that both the direct effects of irrigated agriculture and the indirect effects of its externalities exert a strong influence on the economy throughout the state, although the nature of the influence varies across the landscape and is evolving over time. They also illustrate the wide variety of potential opportunities for future investment in the state's infrastructure. These include situations where investment is required to sustain existing irrigation systems and those where irrigation currently does not exist. The existing irrigation systems include some that have been relatively well-maintained and well-managed, represented by the

Greenfields Irrigation District, and those that have not and face potential collapse without substantial refurbishment, represented by Milk River Irrigation Project. The case studies demonstrate that, in all areas of the state, irrigation systems are interacting with non-agricultural elements of the economy, whether on the periphery of one of the state's urban centers (Bitterroot Valley and Greenfields) or more distant (Milk River and Lower Yellowstone and lower Missouri River Valleys).

These case studies should not in any way be construed as preliminary feasibility analyses for irrigation investments. Instead, they allow us to offer insights into the general trends and factors influencing irrigated agriculture, as well as other goods and services affected by irrigation's externalities, in different regions of Montana.

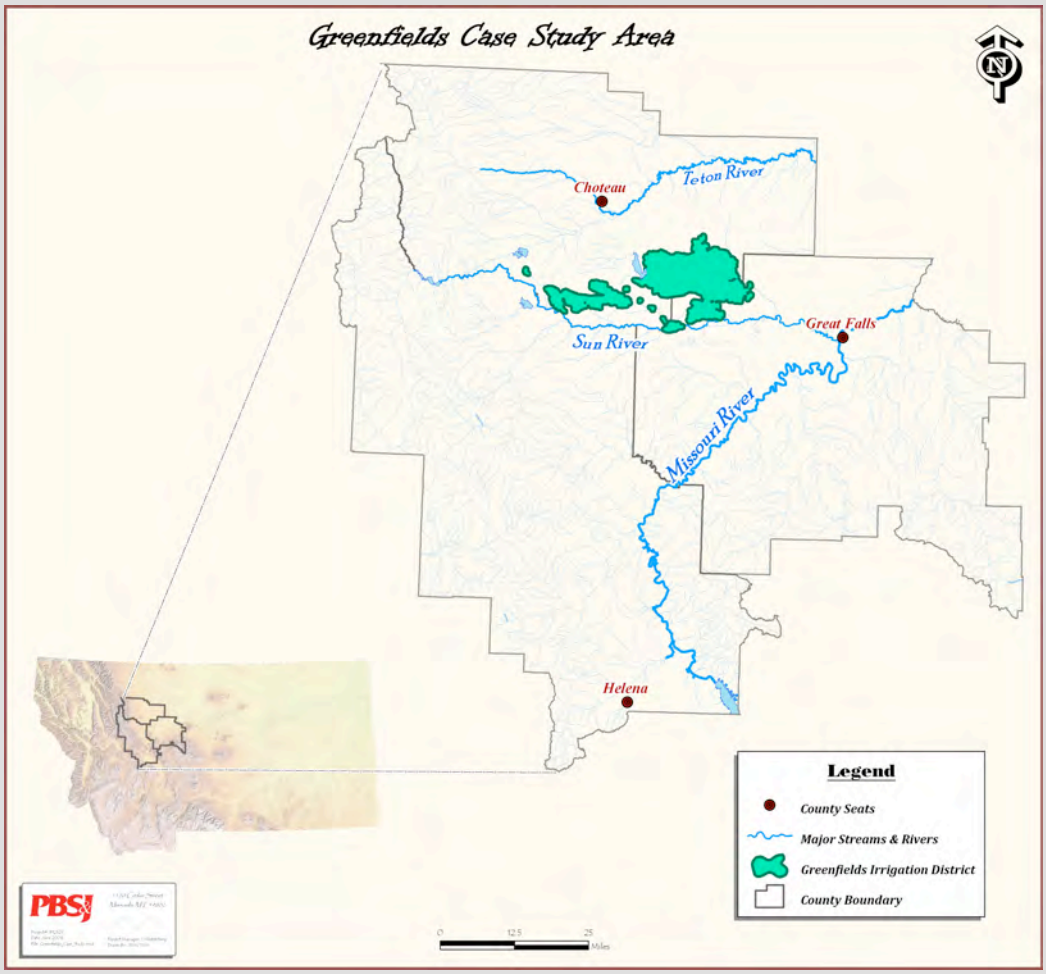
II. Case Study 1: Greenfields Irrigation District

A. Description of the Study Area

1. Study Area Boundaries

The Greenfields Irrigation District (GID) is located in Teton and Cascade Counties, largely centered on the town of Fairfield, about 35 miles northwest of Great Falls. Figure 11-1 shows the study area. The lands served by the GID are located on the north slope of the Sun River Valley, and on a series of benches above Muddy Creek, the largest of which is Greenfields Bench. The Bureau of Reclamation's Sun River Project on Greenfields Bench (Greenfields Irrigation District) is presented here as an example of a well-managed irrigation project. This case study will review its successes, its ongoing issues, and the future challenges that irrigators and managers in the GID will likely confront in the years to come.

Figure II-1. Map of the Study Area



Source: PBS&J

2. Description of the Region's Population and Economy

Teton and Cascade Counties are adjacent to each other and share roughly the same geographic profile, but have vastly different population and economic profiles. Although the immediate topography is characteristic of many agricultural areas in Eastern Montana, and the average annual precipitation recorded at the town of Fairfield is 12 inches,[1] the Rocky Mountain Front and Rocky Mountain outliers such as the Big Belt and Little Belt Mountains are visible from most locations within the case study area. Agriculture in Teton and Cascade County is comprised of a diverse mix of dry rangeland, irrigated range and hay land, irrigated cropland, and dry land crop farming.[2]

Teton County's population is relatively small and dominated by agriculture, while Cascade County, home to Great Falls, is a major urban center in Montana.[3] Great Falls is the third largest city in Montana, and serves as the regional economic center of north-central part of the state. It is located about 35 miles from Fairfield, and while it is the region's major agricultural center, it also hosts a large airbase, and serves as a cultural, retail, and medical center for north-central Montana.[4] Many workers from Teton County commute to work in Great Falls, so the economic fortunes of Cascade County have a strong influence on the population and economy of Teton County.

Cascade County has always been more populous than Teton County, due to the influence of Great Falls. Over the last century, Teton County's population has fluctuated slightly, most notably when it increased during the 1940s through the 1960s, after the construction of the irrigation infrastructure that serves the Greenfields Irrigation District. The populations of both counties peaked during the 1960s, and have declined slightly in the decades since, as Figure II-2 shows. Between 1990 and 2000, the population of Great Falls began to grow again, but projections from 2000 to 2030 suggest that the population of both counties will

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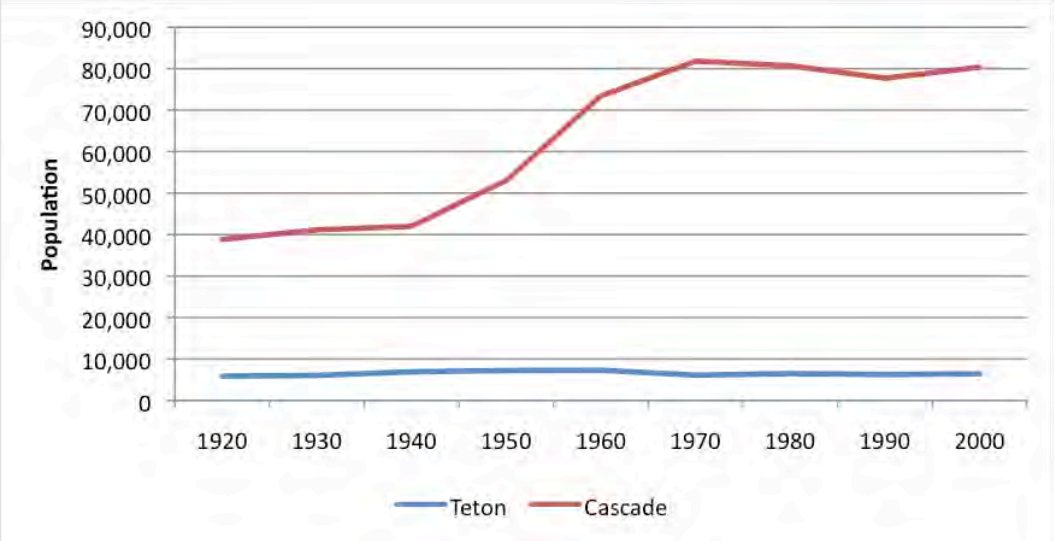
[1] Autobee, R. 1995. *The Sun River Project*. US Bureau of Reclamation. Retrieved June 16, 2008, from http://www.usbr.gov/dataweb/html/sunriverh.html

[2] Montana Natural Resource Information System (NRIS). 2008. *Predominant Agricultural Land Use Classification on Private Lands: Teton and Cascade Counties*. Retrieved May 28, 2008, from http://maps2.nris.mt.gov/mapper/ThemeList.asp?Profile=14519&qLayer1=County&qField1=County&qValue1=Teton&Oper1=&Buffer1=0&TabName=Land%20Information.

[3] The U.S. Bureau of Economic Analysis delineates regional markets throughout the country, which it calls Economic Areas. The Areas consist of economic nodes that are centers of regional commerce, and the surrounding counties that are economically related to the nodes. Montana is divided into four Economic Areas: Great Falls, Billings, Helena, and Missoula. Ravalli County is associated with Missoula. The areas are drawn based on commuting data from the decennial census, on statistical areas from the Office of Management and Budget, and on newspaper circulation data from the Audit Bureau of Circulations. The Bureau of Economic Analysis last redrew the boundaries in 2004.

[4] U.S. Census Bureau. *Census Summary Files 1990/2000*. American Factfinder Website. Retrieved June 16, 2008, from http://factfinder.census.gov/servlet/DatasetMainPageServlet?_program=DEC&_submenuId=&_lang=en&_ts=

Figure II-2. Population Trend for Teton and Cascade Counties between 1920 and 2000



Source: ECONorthwest, with data ECONorthwest, with data from Forstall, R.L. 1995. *Population of Counties by Decennial Census: 1900 to 1990.* U.S. Department of Commerce, Bureau of the Census. March 27. Retrieved June 5, 2008, from http://www.census.gov/population/cencounts/mt190090.txt

continue to decline, by 5.6 percent for Cascade County, and 7.5 percent for Teton County.[5]

In terms of income and financial well-being, by some measures, the people of Teton and Cascade Counties are doing better than the state as a whole. By per-capita personal income, both counties ranked among the highest-income counties in the state.[6] As Figure II-3 shows, unemployment in Teton County is, and has been for some time, lower than the state unemployment rate. The rate in Cascade County has closely followed that of the state. In terms of poverty, however, Teton County has a higher percent of its population below the poverty level (16.6 percent) than the state (14.6 percent), while Cascade County's poverty rate is lower (13.5 percent) than the state as a whole. Over the last few decades, per-capita personal income has risen by more than 25 percent, adjusted for inflation, in both Cascade and Teton Counties.[7] Table II-1, below, summarizes these and other statistics.

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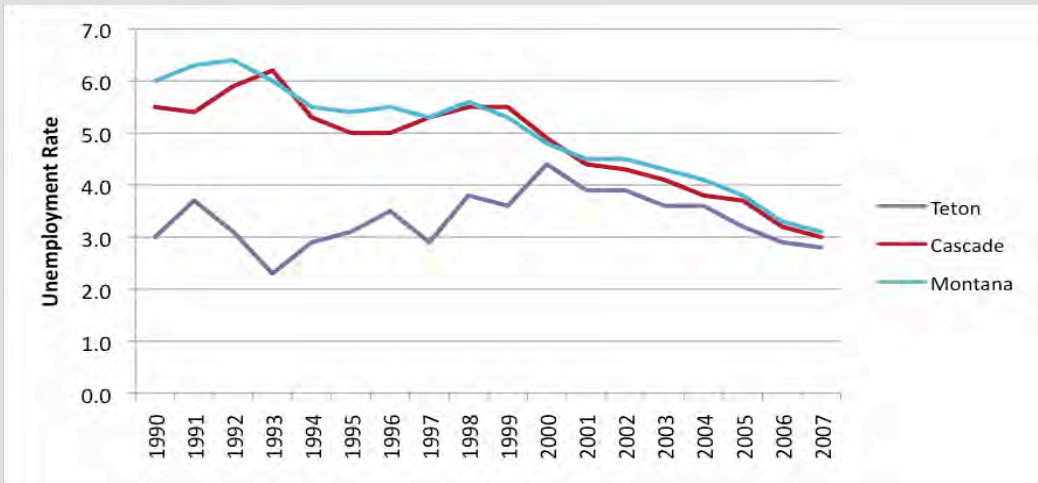
[5] Montana Department of Commerce, Census and Economic Information Center. 2008. *Montana Population Projection, Percent Change Between Census 2000 and NPA Projections for 2030.* March. Retrieved May 22, 2008, from http://ceic.commerce.state.mt.us/Demog/project/PopProjPercentChg2030T(07).pdf

[6] Montana Department of Commerce, Census and Economic Information Center. 2008. *Montana Per Capita Personal Income by County – 2006.* April. Retrieved May 22, 2008, from http://www.ceic.mt.gov/graphics/Data_Maps/PerCapitaIncome06.pdf

[7] Headwaters Economics. 2007. *A SocioEconomic Profile: Cascade County, Montana.* Economic Profile System. November 30. Retrieved May 22, 2008, from http://www.headwaterseconomics.org/

Figure II-3. Average Annual Unemployment Rate For Teton and Cascade Counties and Montana, 1990-2007



Source: ECONorthwest, with data from U.S. Department of Labor, Bureau of Labor Statistics. 2008. Local Area Unemployment Statistics [for Cascade and Teton Counties, and Montana]. Retrieved May 1, 2008, from http://data.bls.gov/PDQ/outside.jsp?survey=la

Farm employment represents a significant portion of total employment in Teton County, but only a small slice of overall employment in Cascade County, as Figure II-4 shows. Farm employment in Teton County was the largest category of employment in 2006, at 20 percent. Government employment, retail trade, construction, and health care represent some of other the larger sectors of employment. In Cascade County, government, retail trade, and health care sectors are all important employers. Since 1970, total employment has grown in both counties, with the fastest growth in the service and professional sectors. Farm employment dropped in both counties during the same time, down 30 percent in Teton County, and 2.5 percent in Cascade County.[8]

This trend in fewer agricultural workers can possibly be explained by the trends in the number and size of farms. The number of farms actually increased in Teton County between 1992 and 2002.[9] However, the number of large farms greater than 1,000 acres has decreased while there has been a surge in the number of smaller farms less than 150 acres. Thus the number of farms that require groups of hired workers has decreased. Additionally, the number of smaller farms that are supported by sources of income other than agriculture has increased.

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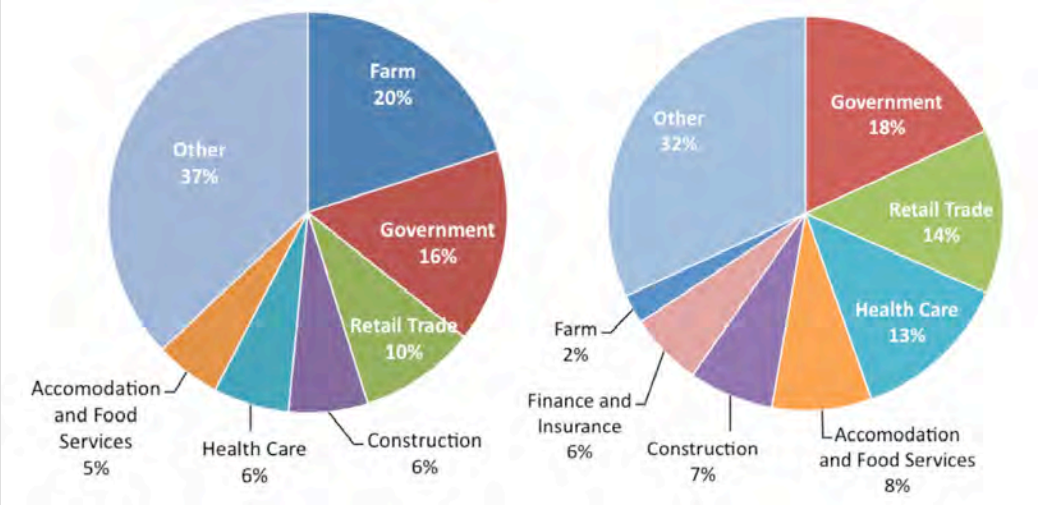
profiles/p_Cascade_County_Montana.pdf; and Headwaters Economics. 2007. *A SocioEconomic Profile: Teton County, Montana.* Economic Profile System. November. Retrieved May 22, 2008, from http://www.headwaterseconomics.org/profiles/p_Teton_County_Montana.pdf

[8] Headwaters Economics. 2007. *See* footnote 7.

[9] U.S. Department of Agriculture. 1992. *Highlights of Agriculture: 1992 and 1987, Teton County, Montana*. Retrieved May 22, 2008, from http://www.nass.usda.gov/census/census92/atlas92/datafile/mtc050.txt

Figure II-4. Employment by Industry in Teton (left) and Cascade (right) Counties, 2006



Source: ECONorthwest, with data from U.S. Department of Commerce, Bureau of Economic Analysis. 2008. *Regional Economic Information System: Table CA25* [for Teton and Cascade Counties]. Retrieved May 6, 2008, from http://www.bea.gov/regional/reis/

Although farm employment represents 20 percent of all employment in Teton County, it represents just 6 percent of total personal income. As farm employment dropped, farm income dropped in Teton County: between 1970 and 2000, it fluctuated widely, but on average declined in inflation-adjusted dollars.[10] Similar trends occurred in Cascade County during the same period.

B. History of Irrigated Agriculture and Investment at the Study Area

The federal government opened the Sun River area of Montana to homesteading in 1862. The Sun River originates in the main body of the Northern Rocky Mountains. It is sustained by large winter snowpacks, resulting in large spring and early summer flows. Large cattle ranches relying on private ditches were scattered along the Sun River and its tributaries before the turn of the century, and began irrigating most of the bottomlands in the drainage a number of years before the Sun River Project was initiated.

The earliest settlers in the bench areas, located up and out of the Sun River bottomlands, were dryland farmers. Some attempted to irrigate but few were successful. In 1884, the Kilraven Company constructed a diversion high up on the Sun River along with 7 miles of ditch. The Company abandoned the project

[10] Headwaters Economics. 2007. *See* footnote 7.

Table II-1. Summary of Demographic and Economic Characteristics of the Case Study Area

	Teton County	Cascade County	Montana
Demographic Statistics			
Population, 2000	6,445	55,716	944,632
Median Age, 2000	40	38	37.5
Percent of Population over 65, 200	16.6%	14.7%	13.4%
High School Graduate or Higher, 2000	83.4%	91.4%	87.2%
Bachelor's Degree or Higher, 2000	20.8%	31.6%	24.4%
Economic Statistics			
Per-Capita Personal Income, 2006	$32,270	$31,740	$30,790
Percent Below Poverty, 2000	16.6%	13.5%	14.6%
Total Employment, 2006	3,682	51,757	637,401
Percent Farm Employment, 2006	20%	2.4%	5%
Unemployment Rate, 2007	2.8	3.0	3.1%

Source: ECONorthwest, with data from U.S. Department of Commerce, Bureau of the Census. 2008. *American Factfinder Fact Sheets* [for Teton and Cascade Counties, and Montana]. Retrieved June 9, 2008, from http://factfinder.census.gov; U.S. Department of Commerce, Bureau of Economic Analysis. 2008. *Regional Economic Information System.* Retrieved June 9, 2008, from http://www.bea.gov/regional/reis; and U.S. Department of Labor, Bureau of Labor Statistics. 2008. *Local Area Unemployment Statistics* [for Teton and Cascade Counties, and Montana]. Retrieved June 9, 2008, from http://www.bls.gov/lau/home.htm

when it realized that the ditch would need to be 40 miles long, and the water would disappear before it reached its intended destination.[11]

Settlement of the bench areas accelerated after 1909, when Congress liberalized the homesteading act allowing each settler 320 acres of free land instead of 160. In 1910, many dryland farmers moved to the Sun River region from eastern Montana and the Dakotas. Fairfield was established in 1915 and enjoyed a brief period of prosperity as the center of a dryland farming area, but declined during the drought of the early 1930s.[12]

The newly formed Reclamation Service (later to be the Bureau of Reclamation) identified the lands for the Sun River Project as early as 1903. After the Bureau of Reclamation conducted a survey that showed a dam could be built in the Sun River Canyon and conveying water for irrigation in the Fairfield area would be feasible, more farmers were attracted to the area. Construction of the Greenfields

[11] Brown, R.H. 1934. "Irrigation in a Dry-Farming Region: The Greenfields Division of the Sun River Project, Montana." *Geographical Review* 24(4): 596-604.

[12] Costello, G. 1941. "First Sun River Irrigation in 1877." *The Montana Farmer* 28(34).

Division began in 1913, and the first water was delivered in 1920. To help provide additional water for the project, five storage reservoirs were designed: Gibson Reservoir, Willow Creek Reservoir, Pishkun Reservoir, Muddy Creek Reservoir, and Benton Lake Reservoir.[13]

Many of the dryland settlers in the area voiced much opposition to irrigation in this allegedly excellent dryland country. In fact, much of the promotion for the project originated with Great Falls business interests, rather than from the project area itself. Existing irrigators were concerned about the additional competition for water, dry land farmers about competition for land.[14] Areas east of the current GID, along Sun River, and north to the Teton River were initially proposed for inclusion within the project.[15] Opposition from a number of dryland farmers resulted in a reduction of the project area, so Muddy Creek and Benton Lake Reservoirs were never developed.

The Gibson Dam was completed in 1929.[16] The development of storage created a level of reliability that had been previously impossible to achieve with the GID's relatively junior direct flow water rights. As clouds of dust choked dryland farming across the Great Plains, farmers moved in rising numbers to irrigated areas like the Sun River Project. Like much of the rural west, the Dust Bowl struck Montana hard. During 1939 and 1940, the Farm Security Administration (FSA) administered the first Federal settlement program in the history of the Sun River Project. The FSA opened more than 20,000 acres in the GID to new settlers.

By 1941, Fairfield was incorporated and had a population of 900 residents, after having dropped to only 150 in 1934. Extensive infrastructure was added, including a telephone system, civic buildings, and power lines. In the five years prior to 1941, the number of farms in the GID increased by 95 FSA-approved farmers to a total of 224.[17] More than 50 years later, in 1992, a farm population of 1,680 people worked on 517 full-time farms. Sun River growers boasted of a gross crop value of $22.7 million that year with each irrigator averaging a return of $200 per acre.[18]

In the mid-1980s, individual growers in the Greenfields Division contracted to grow malting barley for the Anheuser-Busch Company. A decade later, the

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[13] Autobee, R. 1995. *See* footnote 1.

[14] Brown, R.H. 1934. *See* footnote 11.

[15] Montana Dept. of Environmental Quality. 2004. *Water Quality Restoration Plan and Total Maximum Daily Loads for the Sun River Planning Area*. Helena, Montana

[16] Russell Country. 2005. *Welcome to Fairfield, Montana.* Retrieved June 16, 2008, from http://russell.visitmt.com/communities/Fairfield.htm

[17] Costello, G. 1941. *See* footnote 12.

[18] Autobee, R. 1995. *See* footnote 1.

brewery had contracted around 60 percent of GID's 80,000 acres, a percentage that remains largely intact today.[19]

C. Current Status of Irrigated Agriculture and Infrastructure

1. Water Delivery Infrastructure

The Sun River flows from Gibson Dam east toward Great Falls where it joins the Missouri River. Three large storage reservoirs capture off-season and early-season runoff water. Gibson Reservoir on the Sun River can store 105,000 acre-feet of water and is fed by runoff from the Rocky Mountain Front, including the Bob Marshall Wilderness. Water levels in Gibson Reservoir fluctuate significantly to meet irrigation demands for the GID. The reservoir is typically filled during spring runoff and recedes during the irrigation season. The reservoir has a minimum limit of 5,000 acre-feet that is usually set aside for fish populations.

The Project's storage facilities also include two off-stream reservoirs, Pishkun and Willow Creek. Pishkun Reservoir is the off-stream storage reservoir for the GID and is located approximately 15 miles northeast of Gibson Dam. The reservoir's total capacity is 46,700 acre-feet, but the useable capacity is 32,050 acre-feet. The outlet canal (Sun River Slope Canal) has a maximum capacity of 1,600 cubic feet per second, while the incoming canal (Pishkun Supply Canal) has a maximum capacity of only 1,400 cubic feet per second. The reservoir is completely filled during spring runoff and is slowly drawn down to 10 feet below full-pool during the summer irrigation season.

The earth-fill Willow Creek Dam is located on Willow Creek approximately 15 miles southeast of Gibson Dam. The reservoir stores water from Willow Creek and also receives water from the Sun River Diversion Dam via the Willow Creek Feeder Canal. The outlet from the dam can handle a flow up to 300 cubic feet per second. The outlet flows for about 2.5 miles to where it joins the Sun River across from the Floweree Canal, which supplies irrigation water to the Broken O Ranch. The reservoir has a useable capacity of 32,400 acre-feet of water. If available, water is diverted to Willow Creek Reservoir in the fall and/or the spring. The reservoir water level drops about 15 feet on average during irrigation season.[20]

An extensive system of canals delivers water from Gibson and Pishkun Reservoirs to lands irrigated by the GID. The entire delivery and distribution system is made up of 99 miles of main supply canals, 385 miles of lateral distribution lines, and 239 miles of open drains. A 39-mile canal delivers water from Pishkun Reservoir to a concrete drop structure near the town of Fairfield. There are three major drop structures along the canal and several "turnouts,"

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[19] Autobee, R. 1995. *See* footnote 1.

[20] Montana Fish, Wildlife, and Parks. 2008. *Sun River Irrigation Project*. Retrieved June 16, 2008, from http://fwp.mt.gov/education/adoptafish/sunriver/irrigation.html

where water is directed into smaller ditches for irrigation. The upper 25 miles of this canal is referred to as the Sun River Slope Canal and the lower 14 miles is known as the Spring Valley Canal. The Greenfields Main Canal starts at the drop structure near Fairfield and extends more than 25 miles to the northeast. The Greenfields South Canal (17 miles long) branches off about two miles below the start of the Main Canal and heads east. The last of the major delivery canals on the Greenfields Division is the Mill Coulee Canal (10.7 miles long), which feeds from the Greenfields South Canal and travels east and south.

Freezout Lake basin is in the vicinity of Fairfield and receives water from the Sun River Project's irrigation return flows. The Sun River watershed is connected to the Teton River watershed via man-made canals and irrigation works. Thus Water Quality Management Plans for the Teton and Sun Rivers have been developed in a coordinated manner, since water quality in the Teton River basin is intricately linked to actions in the Sun River basin. The connecting point for these watersheds begins with irrigation water applied in the Freezout Lake watershed. Water in Freezout Lake flows to Priest Butte Lake and eventually the Teton River. Target settings of maximum daily load, especially those set for Priest Butte Lake, were developed with an awareness of its potential implication for Freezout Lake, the GID, and the Sun River.[21]

2. Water Use

The Greenfields Irrigation District contains around 84,000 acres (81,000 acres plus 3,169 contract acres if there is surplus water) of irrigated land. The district delivers an average of 250,000 acre-feet of irrigation water per year.[22]

Irrigated agriculture is a primary contributor to the economies of Teton and Cascade Counties. Since its development, GID has transformed the economy of the Sun River Valley. A review of the Water Resource Surveys compiled for the counties that include the Sun River watershed shows that, in combination with its companion Bureau of Reclamation Sun River Project irrigation district, Fort Shaw (10,000 acres), the GID tripled the amount of irrigated land that existed in the watershed prior to its development, from less than 50,000 acres to the nearly 150,000 acres irrigated within the basin today.[23]

In Teton County, the principal crop, by far, is wheat (including winter wheat) with a total harvested acreage of 889,200 acres or 71 percent of the reported harvested crop acreage. However, if only irrigated crops are considered, the principal crop is barley, with a harvested acreage of 46,000 acres or one-third of

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[21] Montana Dept. of Environmental Quality. 2004. *See* footnote 15.

[22] Montana Dept. of Environmental Quality. 2004. *See* footnote 15. Section 2, page 9.

[23] Montana Water Resources Board. 1961. *Water Resources Survey: Cascade County*. Helena, MT.; Montana Water Resources Board. 1962. *Water Resources Survey: Teton County*. Helena, MT.; Montana Water Resources Board. 1957. *Water Resources Survey: Lewis and Clark County*. Helena, MT.

the reported irrigated crop acreage.[24] This acreage is probably mostly located in the Greenfields, area since the principal crops there are malting barley, alfalfa hay, grass hay, and irrigated pasture. By the mid-1990s, the Anheuser-Busch Company contracted approximately 60 percent of the GID's 81,000 acres for malting barley.[25]

The success of irrigated farming in the GID is due in part to the reliability of water supply made possible by a productive watershed combined with a well-developed system of storage reservoirs. In addition, the lands located within the district are generally well-drained and well-suited for growing shallow-rooted grain crops.[26]

Another key contributor to the success of the GID has been its attention to continually maintaining and improving its infrastructure and its ability to effectively manage its water supply. Major maintenance projects have not been deferred.[27] During the 1970s and 1980s, the GID participated in the Bureau of Reclamation's Rehabilitation and Betterment Program. The improvements under this program reduced ditch leakage and improved water measurement capabilities, increasing overall efficiencies on the district by 20 to 25 percent.[28]

On-farm improvements by irrigators have also increased water-use efficiency. As recently as 1980, much of the district was flood irrigated, and efficiencies on those lands averaged only 33 percent. However, the relatively gentle landscape and well-drained soils, in addition to assistance from government programs, such as the Natural Resource Conservation Service's EQIP program combined to encourage a widespread conversion to sprinkler irrigation. Today, 70 percent of the acres in the GID are sprinkler-irrigated, while only 30 percent are flood-irrigated. As a result, water-use efficiency on those acres has increased from 33 percent to 55 to 65 percent.[29]

In recent years, investments in infrastructure and water management have enabled the district to monitor inflows, reservoir levels, outflows, and flows in large ditch systems electronically and instantaneously. These improvements in efficiencies have enabled the district to provide at least two acre-feet per acre to its irrigators in most years, and to continue water deliveries into mid September. However, even with efficient infrastructure and efficient management, low water

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[24] USDA, National Agricultural Statistics Service. 2007. *Quick Stats – Montana County Data.* Retrieved May 7, 2008, from http://www.nass.usda.gov/Statistics_by_State/Montana/index.asp

[25] Montana Fish, Wildlife, and Parks. 2008. *See* footnote 20.

[26] Personal Communication with Bob Hardin, Greenfields Irrigation District Manager. May 6, 2008.

[27] Personal Communication with Bob Hardin. *See* footnote 26.

[28] Personal Communication with Bob Hardin. *See* footnote 26.; Personal Communication with Gerry Nyppen, Project Manager, Lower Yellowstone Irrigation Project. June 4, 2008.

[29] Personal Communication with Bob Hardin. *See* footnote 26.

years, such as 2007, mean irrigators are shut off as early mid August, and supplies per irrigated acres are limited to 1.5 acre feet per acre. [30]

D. Proposed or Recent Investments

The water supply in the Sun River drainage is considered fully appropriated, and the basin is, in fact, closed to most new water right permits.[31]As a result, the GID's focus will, of necessity, be on using its existing water supply more effectively. For example, the GID continues to encourage conversions to sprinkler systems and improvements in on-farm water-use efficiency.

In addition, the district is exploring the potential to increase the storage capacity of Pishkun Reservoir, which is an off-stream storage reservoir. The interest in this project has increased as a result of the major forest fires that occurred in the mountainous upper Sun River watershed in 2007. The fires make it likely that snowpack will exit the mountains earlier and more rapidly than it has in the past, perhaps at a rate that existing storage infrastructure cannot fully accommodate. In anticipation of these changes in the Sun River's hydrology, GID is exploring the feasibility of increasing the size of the diversion structure serving Pishkun, as well as Pishkun itself, to accommodate higher flows.[32]

Finally, although it does not represent an infrastructure investment in the traditional sense, the pending completion of the Water Court's adjudication of the Sun River basin should have the practical effect of more-precisely-quantifying the district's water rights, and as a result, its water supply.[33] The district has actively participated in this process over the past 20 years.[34] Most of the private irrigation in the Sun River bottomlands pre-dates the GID's water rights. As a result, those bottomlands typically have senior water rights. The completion of the adjudication, which will establish upper limits for those senior rights, will help define and protect GID's water rights as well.

E. Goods and Services Affected by Irrigation

1. Primary Goods and Services

The application of irrigation water to crops produces economic benefits in two ways: by increasing the yield of a crop that was previously cultivated without

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[30] Personal Communication with Bob Hardin. *See* footnote 26.

[31] Montana Code Annotated 85-2-342 – Upper Missouri River Basin Closure.; Montana Code Annotated 85-2-343 – Upper Missouri River Basin Closure Exceptions.

[32] Hardin, B. 2007. "Water Season." *Greenfield Irrigation District Newsletter*. August.

[33] Montana DNRC. 2008. *Water Adjudication Status Report*. Retrieved June 2, 2008, from http://dnrc.mt.gov/wrd/water_rts/adjudication/default.asp

[34] Personal Communication with Bob Hardin. *See* footnote 26.

irrigation, or by enabling a farmer to grow a higher-valued crop. The benefits provided by irrigation show up in the net farm income a farmer is able to earn from the crop, which is also translated into the value of land.

Net Farm Income. Data are unavailable to determine the increase in net farm income provided by irrigation in the GID, however, data that are available indicate that irrigation probably contributes substantially to farmers' overall net income. In 2006, net farm income in Teton County was $8.7 million. Compared to many regions of Montana, where positive returns in agriculture, even irrigated agriculture, are not guaranteed, the county's farmers rarely have difficulty earning enough income from cash receipts, government payments, and other farm-related income, to cover their production costs. In Teton County, net farm income has been negative in just four of the last 35 years.[35] This is not to say that net farm income does not fluctuate widely with the markets—it does; but the fluctuations rarely dip into negative territory.

Many Montana commodities are exported directly from the state with little or no value added, to out-of-state or out-of-country processors. The irrigated barley produced in the Greenfield Irrigation District, however, is processed locally and contributes additional income to the county's economy. Anheuser Busch's grain processing facilities in Fairfield, and the recent construction of large malting plant in nearby Great Falls both provide economic benefits generated directly from the Greenfields Irrigation District.

Land Values. Irrigation increases the value of land in the GID, but the specific value of the increase is highly dependent on the specifics of each property, and the characteristics of the irrigation system. For example, an acre of irrigated land in the GID is more valuable than an equivalent acre of non-irrigated land nearby, all else equal, because of the benefits the water provides. Moreover, an acre of irrigated land in the GID is generally more valuable than an equivalent acre of irrigated land in other nearby irrigation districts, because the GID has one of the most reliable delivery systems in the state, so farmers there are more likely than farmers in other districts to receive their full share of water.[36] The specific increase in value that irrigation provides is difficult to determine in this area, because factors other than irrigation are heavily influencing land values in this market. Properties to the east of Fairfield are close enough to Great Falls that people are purchasing them as hobby farms rather than income-earning properties, and commuting to work in Great Falls. Property values to the west of Fairfield are being influenced by the recreational and amenity factors that are driving the market for land in western Montana. Few properties in this area are being sold purely for production agriculture anymore.

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[35] Headwaters Economics. 2007. *See* footnote 7.

[36] Personal communication with Ralph Gourley. Appraiser, Gourley & Company. May 23, 2008.

2. Complementary Goods and Services

Greenfields Irrigation District and its infrastructure provide benefits in addition to those derived directly from agricultural production. The reservoirs in the area provide recreational opportunities and flood control, and the proximity between irrigation-sustained wetlands and grain crops grown in the district provide excellent stopover habitat for migratory birds. We describe each of these complementary goods and services in more detail below.

Recreational Opportunities. Gibson Reservoir, Willow Creek Reservoir, and Pishkun Reservoir, which each feed irrigation water to the Greenfields Irrigation District, are also used by locals and visitors for hunting, fishing, boating, swimming, picnicking, and other recreational activities. Gibson Reservoir's fishery consists of rainbow trout, west slope cutthroat trout, and arctic grayling. Daily or annual user data are not available for these sites, but Montana Fish, Wildlife, and Parks (FWP) does keep track of how many days people fish these lakes. In 2005, the last year for which data were available, anglers fished a total of 11,295 days. The average days fished over the last ten years was slightly higher, at 13,157. These are not the most popular fishing sites in the region by far: in 2005, Gibson ranked 48 in the region in terms of number of days fished, Willow Creek ranked 16, and Pishkun ranked 27, out of 62 sites surveyed in the region.[37] These sites compete in the same region with world-class fishing opportunities available on the Upper Missouri River, less than 100 miles away.[38]

Wildlife Habitat. Irrigation drainage canals have also contributed to sustaining Freezout Lake, one of the premier bird watching sites in Montana, if not the Rocky Mountain region.[39] Freezout Lake lies at the western edge of the Fairfield Bench. For many years before any irrigation, this lake furnished good duck hunting. Currently there are 27 drains entering Freezout Lake originating from irrigation of surrounding farmland and Montana FWP estimates that 80 to 90 percent of water entering Freezout Wildlife Management Area (WMA) is from three drainage ditches originating in the GID.[40] Water levels are regulated for bird production and to moderate salinity levels in the Teton River. As a result, Freezout Lake has evolved into Montana's primary snow goose staging area, a place where as many as 300,000 snow geese and 10,000 tundra swans gather and rest before flying onward. They are attracted to this lake in particular because its

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[37] Montana Fish, Wildlife, and Parks. 2008. *Montana Fishing Guide.* Retrieved May 22, 2008, from http://fwp.mt.gov/fishing/guide/default.aspx

[38] Montana Fish, Wildlife, and Parks. 2000. *MFWP Stream Fishery Classification: 1999 Final Sport Fisheries Value – Class I and II Streams.* January 13. Retrieved May 22, 2008, from http://fwp.mt.gov/FwpPaperApps/fishing/class1and2.pdf

[39] Larcom, C. and L. Larcom. 2008. "10 Great Spots to Watch Birds in Montana." *Montana Outdoors.* May-June. Retrieved May 23, 2008, from http://fwp.mt.gov/mtoutdoors/HTML/articles/2008/10birdingspots.htm

[40] Personal communication with Mark Schlepp, Manager, Freezout Wildlife Management Area, Montana Fish, Wildlife, and Parks. May 23, 2008.

ponds provide safety, and the surrounding barley fields provide a reliable source of food.[41] Data on the number of people who come to Freezout Lake to bird watch are not collected regularly, but park officials estimate that the area receives about 4,000 vehicle trips per year.[42] With a reputation of being among the best places to bird watch in Montana, it is a destination for both residents and out-of-state visitors. National research suggests that the net economic value of bird-watching for residents is about $40 per day. For those who come from out of state to bird watch, the value is even higher, about $154 per day.[43] These data indicate that the total net economic value provided to the state by this irrigation-related feature is not trivial. In addition to the habitat's recreational benefits, it may also provide benefits to society insofar as people who never visit the lake value the continued existence of the migratory bird populations, which Freezout Lake helps to support.

Flood Control. Gibson Reservoir is believed to have reduced damage the from the 1964 flood that caused millions of dollars of damage and widespread loss of life along the Rocky Mountain Front. A combination of heavy rains along the Continental Divide and heavy snowmelt lifted 60,000 cfs of floodwater three feet over the top of Gibson Dam. The flood was the largest in the recorded history of the Sun River Valley, as certain places along the river received 14 inches of rain during the 37-hour storm.[44] The Bureau of Reclamation estimates that between 1950 and 1999, Gibson Reservoir provided over $3 million in flood control benefits.[45]

3. Competing Goods and Services

The Greenfields Irrigation District also generates negative externalities that result from the impact of irrigation on water quantity and quality. These impacts negatively affect both recreation and instream and riparian fish and wildlife habitat, and impose regulatory costs on the taxpayers of Montana.

Irrigation withdrawals from the Sun River for the Greenfields Irrigation District impact flow levels in the Sun River throughout the irrigation season, leading to impaired water quality, low instream flows, and flow fluctuations that increase

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[41] Montana Fish, Wildlife, and Parks. No Date. *Sai Yai Ksi Q Tsi Tau Toh Pi "When the Geese Come."* Freezout Lake Wildlife Management Area. Retrieved May 23, 2008, from http://fwp.mt.gov/content/getItem.aspx?id=12389

[42] Personal communication with Mark Schlepp. *See* footnote 40.

[43] La Rouche, G.P. 2001. *Birding in the United States: A Demographic and Economic Analysis: Addendum to the 2001 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation.* U.S. Fish and Wildlife Service, Division of Federal Aid. Report 2001-1. Retrieved May 22, 2008, from http://www.fs.fed.us/outdoors/naturewatch/start/economics/Economic-Analysis-for-Birding.pdf

[44] Autobee, R. 1995. *See* footnote 1.

[45] U.S. Department of the Interior, Bureau of Reclamation. No Date. *Sun River Project*. Retrieved May 22, 2008, from http://www.usbr.gov/dataweb/html/sunriver.html

stream channel erosion, particularly in the smaller tributaries, such as Muddy Creek.[46] Of the 84,000 acres of irrigated on the Greenfields District, about 50,000 acres of irrigated land on the Greenfields Bench drain to Muddy Creek.[47]

As a result of the withdrawals from the Sun River, Montana FWP has designated the main stem of the Sun River below Gibson Dam as chronically dewatered.[48] In 2000 and 2003, the Montana Department of Environmental Quality (Montana DEQ) designated the Sun River, as well as many of its tributaries, including Muddy Creek, as impaired under its 303(d) list. High levels of nutrients caused the river to fall short of state water quality standards for aquatic life and cold water fishery uses. Agricultural practices were largely to blame for the Upper Sun River's elevated nutrient levels. Irrigation and stormwater runoff carried excess nutrients from over-fertilized fields and poorly managed livestock production areas into the river.[49]

The state has developed a watershed protection plan and total maximum daily load (TMDL) guidelines to work towards improving water quality.[50] Responding to the TMDL plan, partners have helped implement numerous water quality improvement projects in the Upper Sun River watershed. As a result of these efforts, Montana DEQ removed some segments of the area's rivers and streams, including the Upper Sun River, from the impaired list for nutrients.[51]

The impacts of irrigation on water quality and quantity in the Sun River drainage can negatively affect fish and wildlife habitat and in-stream river recreation. In the Sun River, inadequate streamflows elevate water temperatures with damaging consequences to the trout fishery. Montana FWP estimates that around 9,000 angling days occurred on this stretch of the Sun River in 2005.[52]

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[46] Hershberger, K. and J. Bauder. 2005. *2004 Sun River Watershed Water Quality Monitoring Project.* Montana State University, Bozeman, Department of Land Resources and Environmental Sciences, Water Quality and Irrigation Management. Retrieved May 27, 2008, from http://waterquality.montana.edu/docs/watermonitoring/SunRiver2004.shtml

[47] Montana Dept. of Environmental Quality. 2004. Water Quality Restoration Plan and Total Maximum Daily Loads for the Sun River Planning Area. Helena, Montana.

[48] Montana Department of Fish, Wildlife & Parks, Natural Resource Information Service and SteamNet. 2008. "Montana Fisheries Information System Database Query." *Montana Fisheries Information System*. Retrieved May 27, 2008, from http://maps2.nris.state.mt.us/scripts/esrimap.dll?name=MFISH&Cmd=INST

[49] U.S. Environmental Protection Agency. 2008. *Section 319 Nonpoint Source Success Stories*. Retrieved June 12, 2008, from http://www.epa.gov/nps/success/state/mt_sun.htm

[50] Montana Department of Environmental Quality. 2004. *Water Quality Protection Plan and TMDLs for the Sun River Watershed.* December. Retrieved May 27, 2008, from http://www.deq.state.mt.us/wqinfo/TMDL/SunRiverFinalTMDL/MasterSunTMDL.pdf

[51] U.S. Environmental Protection Agency. 2008. *See* footnote 49.

[52] Montana Fish, Wildlife, and Parks. 2008. *Fishing Access Guide: Sun River.* Retrieved May 27, 2008, from http://fwp.mt.gov/fishing/guide/q_Sun_River__1113124474942_0_102.361000061035.aspx

Irrigation's impact on both quantity and quality of water can negatively affect the net economic value of anglers' fishing experience. The exact amount by which irrigation reduces the benefits enjoyed by in-stream anglers in this part of the state depend on the degree to which dewatering impacts fish populations and stream conditions at any given time. The Sun River is also known as a challenging river for whitewater rafting when flows are sufficient, with class III rapids throughout its upper reaches. The Sun River receives moderate boating pressure, but access is limited by a scarcity of public lands in the area. This, along with persistent low flows throughout irrigation season make this river less attractive to boaters than it otherwise would be.[53]

Irrigation also imposes costs on the taxpayers of Montana insofar as the state must dedicate limited resources to developing and implementing regulatory requirements and plans to improve water quality—resources which otherwise could have been allocated to other activities.

4. Trends and Factors Influencing Goods and Services

The primary future challenge facing the GID may not be how to increase irrigated acres, but rather how to sustain and better-serve existing levels of irrigation, especially as other trends and factors, such as climate change and increased land prices increase competition for water among a variety of users.

Competition for land and water resources will likely increase due to climate change and increased demand for instream flows and higher-quality water from people moving into the area for its scenic and recreational amenities. The same category of wealthy land buyer that has boosted land prices in the western parts of the state has discovered the Rocky Mountain Front. While most of that real estate activity is occurring closer to the Rocky Mountain Front, west of the GID, prices on the Greenfields Bench, particularly on its western extent, are already being affected by this activity. To the east of the GID, the city of Great Falls has seen a relatively slow rate of growth in recent years. However, the Fairfield area lies within reasonable commuting distance of Great Falls, and land prices are already being pushed upward because of that proximity. In addition to causing conversion of agricultural land to less-economic units and in some cases to non-irrigated land, this land-use trend can greatly complicate water delivery and water management.

Greenfields has anticipated these problems, and its managers have already begun to develop policies to address increased subdivision pressures. Based, in part, on experiences shared by managers of the Bitter Root Irrigation District, (See Case Study 2), the district will not provide any delivery structure for parcels divided to less than 40 acres in size. Those properties are required to rely on existing infrastructure, unless additional infrastructure is constructed within the

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[53] Fisher, H and C. Fisher. 2008. *Paddling Montana, 2nd Edition.* Helena, MT: Falcon.

property at the owner's expense. Even then, delivery is only assured to pre-existing structures.[54]

Climate change will increase demand for water, due to higher average temperatures, and at the same time, it will negatively affect water supplies. Reduced snowpack in the Rocky Mountains will result in small spring and summer flows, providing less water during critical times for irrigators. As described above, the forest fires of 2007 may also affect the district's water supply, as it will need to adjust its operations to maximize the amount of water it can capture under a new hydrologic regime. Because its existing infrastructure is not in disrepair, it is relatively well-positioned to make infrastructure adjustments necessary to capture more extreme spring flows, and is less vulnerable to any shortfalls that might occur in the interim.

F. Summary and Expectations for Future Investments

We present the GID as an example of an irrigation system that allows irrigators maximize their potential net income, through well-maintained infrastructure, a well-managed water delivery system, and thoughtful planning to anticipate and deal with future challenges. These factors undoubtedly contribute to the fact that the famers in the counties where GID is located regularly generate positive net farm income, and land prices in the GID are higher, relative to other irrigation districts nearby.

The GID produces both positive and negative externalities. The Project's reservoirs offer recreational opportunities, and irrigation drainage water has been managed to support some of the highest-quality migratory bird habitat in the state, if not the Rocky-Mountain region. The project also produces negative externalities, related to poor water quality resulting from elevated nutrients and other pollution in agricultural runoff, as well as reduced flows resulting from irrigation withdrawals and upstream storage. These impacts impose costs on fish and wildlife, anglers, river rafters, and property owners adjacent to poor-quality streams. They also increase regulatory and management costs, shouldered by Montana's taxpayers. The GID is working to reduce these externalities by making system upgrades and helping farmers change irrigation and production practices to reduce nutrients and pollution from agricultural runoff, and by increasing irrigation-system efficiency to reduce withdrawals. The GID's attention to on-going maintenance and improving the efficiency of its operations have allowed it to respond relatively quickly and effectively to many of these water-quality and water-quantity challenges.

Because no new water rights can be established in the basin, the GID has begun to explore other avenues to sustain and improve irrigation. Opportunities that have been proposed include increases in water-use efficiency through expanded sprinkler irrigation systems, careful management of its existing water and land

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[54] Personal Communication with Bob Hardin, Greenfields Irrigation District Manager. May 6, 2008.

resources, and possible modifications to existing storage reservoirs to increase the amount of water available during the irrigation season. Each of these opportunities must be considered carefully for its potential effects on the full range of goods and services produced by water resources in the region. Many of these opportunities would have a positive effect on goods and services produced both directly through irrigation, and external to irrigation. Other opportunities may result in some negative effects, which must be weighed carefully against the positive effects to determine the net benefits and impacts the opportunities would produce for Montanans as a whole.

III. Case Study 2: Irrigation in the Bitterroot Valley

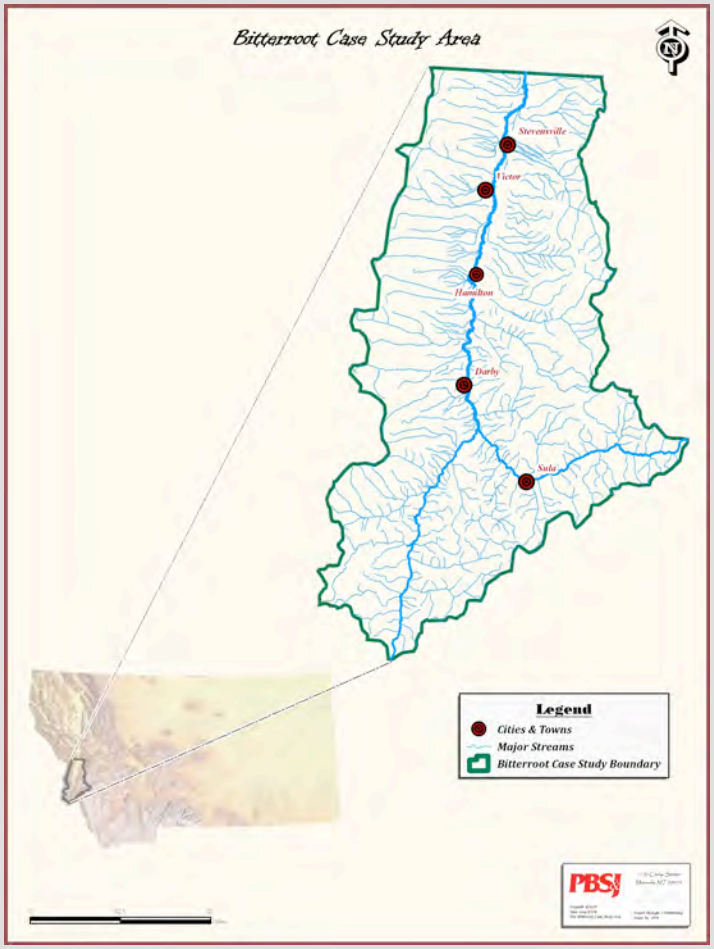
A. Description of the Study Area

1. Study Area Boundaries

The Bitterroot Valley is located south of Missoula, in Ravalli County. The valley runs north-south through the heart of Ravalli County, bounded to the east by the Sapphire Mountains and to the west by the Bitterroot Mountains. Its historically irrigated bottom and bench lands form a band up and down the valley that varies from two to ten miles in width. Most of the valley's irrigated land lies in Ravalli County, and although some additional irrigated land lies in Missoula County to the north, we draw our case study boundary around Ravalli County. Figure III-1 shows a map of the study area.

Ravalli County's largest town and county seat is Hamilton, which is located near the center of the county and had a population of 3,705 in 2000. Montana Highway 93, which connects Ravalli County to Missoula, runs along the Valley

Figure III-1. Map of the Bitterroot Valley Case Study Area



Source: PBS&J

bottom, following the path of the Bitterroot River. Eight other towns, with populations ranging from just over 400 to several thousand, are scattered north to south along the river and the highway.[55] The Bitterroot National Forest and several wilderness areas, including the Selway-Bitterroot Wilderness surround the valley. These areas, along with the Bitterroot River and its tributaries are the basis of the region's budding recreation and tourism economies, and provide a spectacular scenic backdrop for the Bitterroot Valley's communities.

2. Description of the Region's Population and Economy

In recent years, Ravalli County has experienced unprecedented growth. Through the 1990s, it was one of the fastest growing counties in Montana, and through the 2000s, it has remained in the top five.[56] With rapid growth has come shifting demographic patterns and development that is transforming the traditional agricultural landscape. Although it has always been connected to the economic center of Missoula to the north,[57] its economic and community ties to that city have strengthened as many of the new residents commute north for work, shopping, and entertainment. The proximity of Ravalli County to Missoula influences the population, employment opportunities, and economy of the Bitterroot Valley.

The U.S. Census Bureau estimated Ravalli County's population to be 40,396 in 2007, the last year for which data were available.[58] Between 1990 and 2007, the population increased by 62 percent, and as Figure III-2 shows, it is expected to continue growing through at least the next decade.[59] Much of this population growth has occurred outside of incorporated areas. The total population of all the towns in Ravalli County in 2000 was 10,319, indicating that only about a quarter of the inhabitants of Ravalli County live in "urban" areas.

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[55] U.S Department of Commerce, Census Bureau. *American FactFinder [Census 2000 Data]*. Retrieved May 21, 2008, from http://factfinder.census.gov/home/saff/main.html?_lang=en

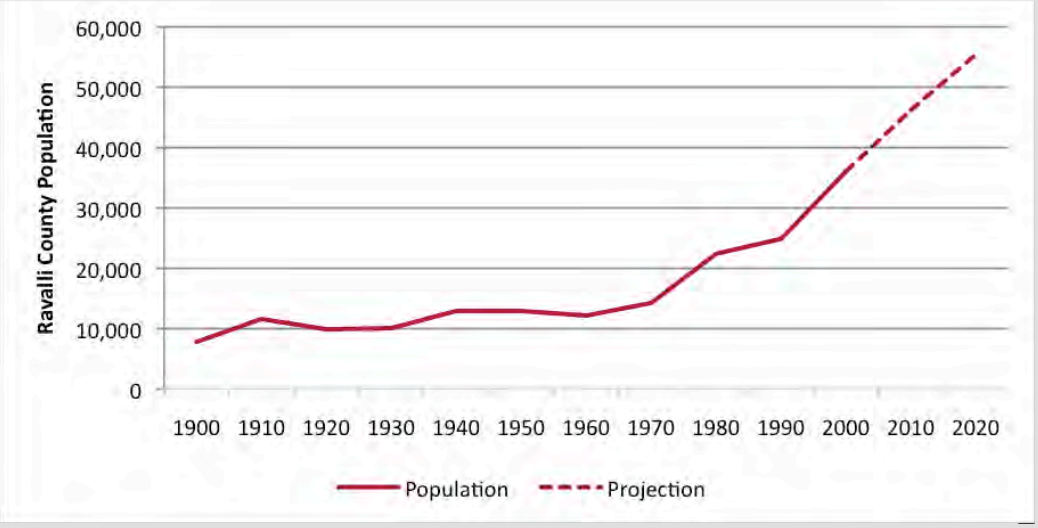
[56] Backus, P. 2007. "Zoning Effort in Ravalli County Heats Up." *The Missoulian*. December 9. Retrieved May 16, 2008, from http://www.missoulian.com/articles/2007/12/09/news/local/news02.txt

[57] The U.S. Bureau of Economic Analysis delineates regional markets throughout the country, which it calls Economic Areas. The Areas consist of economic nodes that are centers of regional commerce, and the surrounding counties that are economically related to the nodes. Montana is divided into four Economic Areas: Great Falls, Billings, Helena, and Missoula. Ravalli County is associated with Missoula. The areas are drawn based on commuting data from the decennial census, on statistical areas from the Office of Management and Budget, and on newspaper circulation data from the Audit Bureau of Circulations. The Bureau of Economic Analysis last redrew the boundaries in 2004.

[58] U.S. Department of Commerce, Census Bureau. 2008. *Population Finder [Ravalli County].* Retrieved May 21, 2008, from http://www.census.gov/.

[59] NPA Data Services, Inc. 2007. *Montana Population Projections*. Montana Department of Commerce, Census and Economic Information Center. November. Retrieved May 21, 2008, from http://ceic.commerce.state.mt.us/Demog/project/NPActy_total_and_65+_1107_web.pdf

Figure III-2. Population Trend and Projected Growth for Ravalli County between 1900 to 2020



Source: ECONorthwest, with data from Forstall, R.L. 1995. *Population of Counties by Decennial Census: 1900 to 1990.* U.S. Department of Commerce, Bureau of the Census. March 27. Retrieved June 5, 2008, from http://www.census.gov/population/cencounts/mt190090.txt and NPA Data Services, Inc. 2007. *Montana Population Projections.* Retrieved June 9, 2008, from http://ceic.commerce.state.mt.us/Demog/project/NPActy_total_and_65+_1107_web.pdf

There are a number of reasons for the dramatic increase in the population of Ravalli County and the Bitterroot valley. Many people are drawn to the area's rural landscape and natural-resource amenities—they want to live in the country, but need or want to be close to a major city. Evidence of this is provided by the fact that over 15 percent of the workers in Ravalli County commute to work outside of Ravalli County, mostly to the north in Missoula.[60] Many people also see moving to the area as a way to afford a larger house or more property: undeveloped land in the valley has generally been less expensive than vacant land in Missoula, and relaxed zoning rules have made development relatively easy, although that is beginning to change in response to the burgeoning growth.[61]

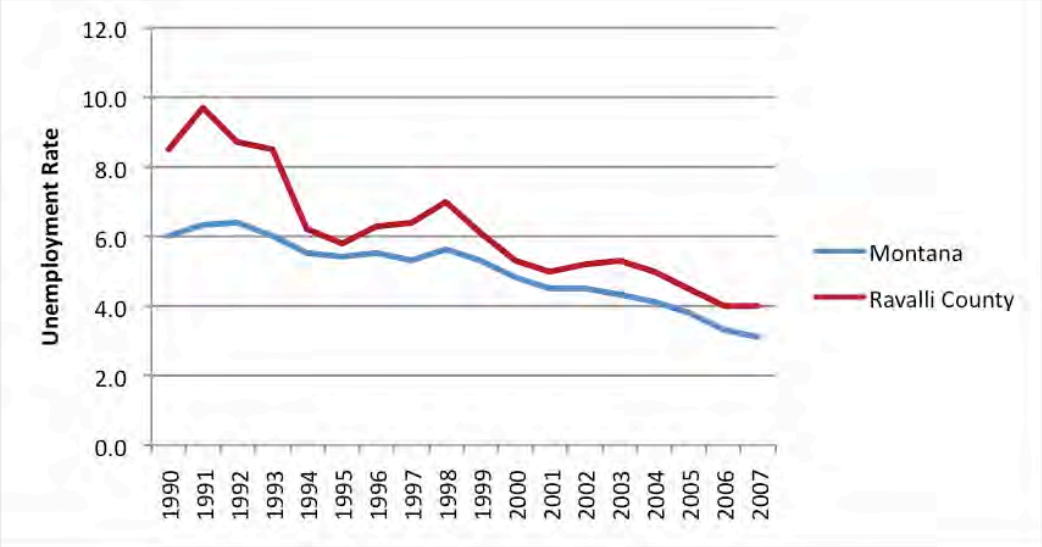
The population growth in Ravalli County has not occurred evenly across all age groups; the greatest increase has been among people approaching retirement—people in their mid-to-late 40s and 50s. The population often considered to be of "retirement age"—those 65 or older, has not increased nearly as fast as those slightly younger.[62] In 2000, the median age for the county was 41.1, older than

[60] Swanson, L. 2001. *The Bitterroot Valley of Western Montana: Area Economic Profile.* University of Montana, O'Connor Center for the Rocky Mountain West. May. Retrieved May 21, 2008, from http://www.fs.fed.us/rm/pubs_other/rmrs_2001_swanson001.html.

[61] Gallob, J. 2008. "Brothers See Zoning as a Way to Preserve Ag." *Ravalli Republic.* April 8. Retrieved May 20, 2008, from http://www.ravallirepublic.com/articles/2008/04/08/news/news03.txt

[62] Swanson, L. 2001. *See* footnote 60.

Figure III-3. Average Annual Unemployment Rate for Ravalli County and Montana, 1990-2007



Source: ECONorthwest, with data from U.S. Department of Labor, Bureau of Labor Statistics. 2008. *Local Area Unemployment Statistics* [for Ravalli County and Montana]. Retrieved May 1, 2008, from http://data.bls.gov/PDQ/outside.jsp?survey=la

the population of Montana as a whole by several years. The population is expected to continue to age, and the percent 65 or older will grow more rapidly over the next decade as the middle-aged population that has moved into the area in recent years ages.

Per-capita income in the Ravalli County is lower than the state as a whole, as it has been for some time, but it has steadily grown in inflation-adjusted dollars over the last few decades. The level of per-capita income, and the rate of growth are lower than in nearby urban areas, but similar to other western counties making the transition from a resource-extraction-based economy to an amenity-based economy.[63] Ravalli County has a higher percent of the population below the poverty level, and its unemployment rate is higher, compared to the levels for Montana as a whole, although the unemployment rate has declined with the state rate over the last decade, as Figure III-3 shows.

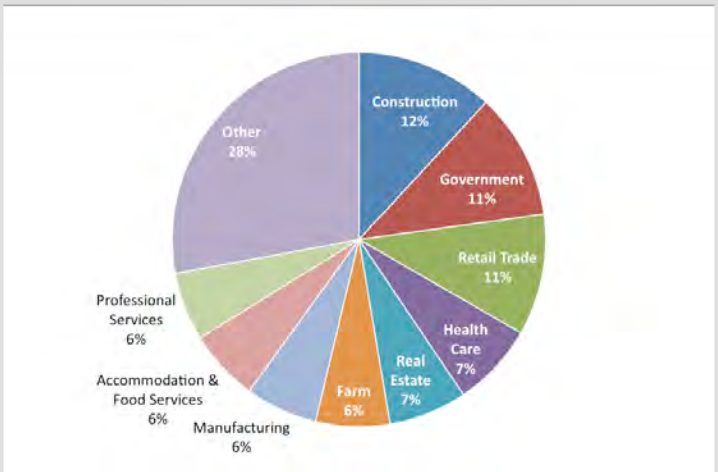
The income of Ravalli County's residents comes from three sources: wages from labor, payments from the government, such as social security, and investment income, including income from rent and dividends. Ravalli County's residents earn a larger share of income from non-wage sources than other counties in Montana. In 2006, just 54 percent of income came from wages and salaries earned through employment. Over the long-term, the income from non-labor earnings has increased faster than wages and salaries, and this trend is expected to

[63] Swanson, L. 2001. *See* footnote 60.

continue, especially as the percent of the retirement-age population increases over the next decade. This shift implies that the industry and employment mix of the area will have less direct influence on Ravalli County's economy in coming years.[64]

Figure III-4 shows the types of employment in Ravalli County in 2006. While agriculture once provided much of the employment of the region, farm employment accounts for only about 6 percent of total employment today. Other sectors have grown with the area's population and economy, including construction, retail, and the service sector. Today the service sector is the fastest growing sector of Ravalli County's economy—it grew by over 30 percent between 1990 and 2000, and continues to increase. The service sector, which includes jobs in health care, legal services, social services, and business and management, contains some of the highest and lowest-earning jobs. Ravalli County has a relatively high level of self-employment, which can be indicative of an entrepreneurial economy. Proprietor employment accounted for about 40 percent of all employment in 2006. High levels of self-employment also can indicate that there aren't enough full-time wage and salary positions available.[65] Some anecdotal evidence indicates that many well-educated people come to Ravalli County for its amenities, without certain employment prospects. Once

Figure III-4. Employment by Industry in Ravalli County, 2006



Source: ECONorthwest, with data from U.S. Department of Commerce, Bureau of Economic Analysis. 2008. *Regional Economic Information System: Table CA25* [for Ravalli County]. Retrieved May 6, 2008, from http://www.bea.gov/regional/reis/

Note: Other includes Administrative and Waste Services, Arts, Entertainment, and Recreation, Finance and Insurance, Wholesale Trade, Transportation and Warehousing, and Other Services.

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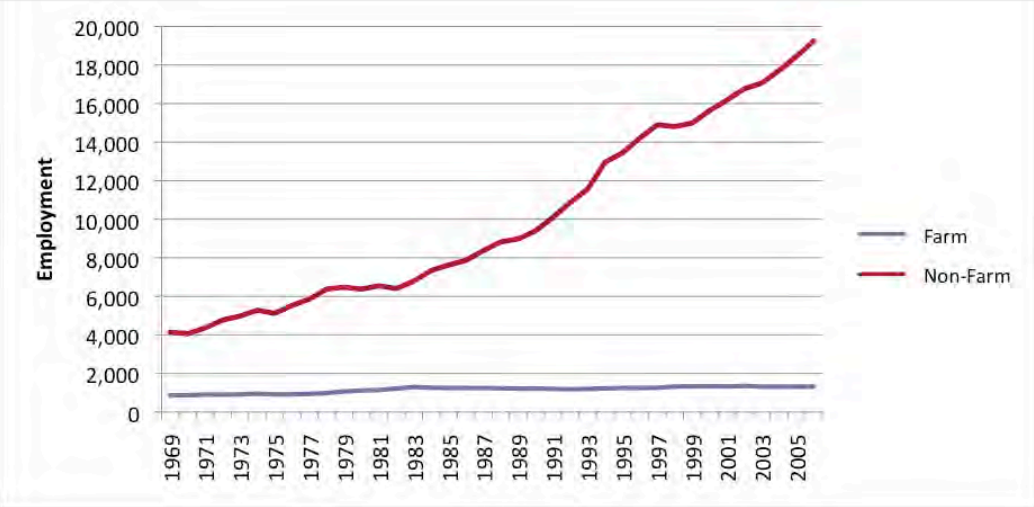
[64] Swanson, L. 2001. *See* footnote 60.

[65] Bitter Root Resource Conservation & Development Area, Inc. 2002. *Comprehensive Economic Development Strategy & Bitter Root Resource Conservation & Development Area Plan for Missoula, Mineral, and Ravalli Counties.* July.

Figure III-5. Total and Farm Employment in Ravalli County, 1969 to 2000



Source: ECONorthwest, with data from U.S. Department of Commerce, Bureau of Economic Analysis. 2008. *Regional Economic Information System, Table CA25*. Retrieved June 9, 2008, from http://www.bea.gov/regional/reis/

they arrive, they often stay in the area without a full-time job, working seasonal jobs or remaining unemployed, waiting for a permanent opportunity to arise.[66]

Farm employment has held steady in Ravalli County over the last few decades, but has been dropping as a percent of total employment, as Figure III-5 shows. Total employment has increased almost 300 percent over the last decades, while farm employment remained stagnant, providing fewer than 1,500 of the more than 20,000 jobs in the county in 2006. Although farm employment represented 6 percent of total employment, it accounted for less than 1 percent of total income.

B. History of Irrigated Agriculture and Investment at the Study Area

A relatively mild climate, good snowpacks in the Bitterroot and Sapphire Mountain ranges that parallel the irrigated corridor on the west and east respectively, numerous tributary streams, and topography that lends itself to an extensive and elaborate network of small irrigation ditches make the naturally-arid valley bottoms and benchlands (which receive 13 inches of precipitation per year, on average) appear lush and green for much of the summer and into the fall.

Although it is one of Montana's westernmost valleys, the Bitterroot was one of the first to be settled and irrigated. An 1852 water right on Burnt Fork Creek near Stevensville is believed to be the oldest irrigation-based water right in Montana. The relatively narrow valley topography, relative abundance of water and mild

[66] Bitter Root Resource Conservation & Development Area, Inc. 2002. *See* footnote 65.

Table III-1. Summary of Demographic and Economic Characteristics of the Case Study Area

	Ravalli County	Montana
Demographic Statistics		
Population, 2000	36,070	944,632
Median Age, 2000	41.1	37.5
Percent of Population Over 65, 2000	15.4%	13.4%
High School Graduate or Higher, 2000	87.4%	87.2%
Bachelor's Degree or Higher, 2000	22.5%	24.4%
Economic Statistics		
Per-Capita Personal Income, 2006	$26,672	$30,790
Percent Below Poverty, 2000	13.8%	13.6%
Total Employment, 2006	20,571	637,401
Percent Farm Employment, 2006	6%	5%
Unemployment Rate, 2007	4%	3.1%

Source: ECONorthwest, with data from U.S. Department of Commerce, Bureau of the Census. 2008. *American Factfinder Fact Sheets* [for Ravalli County and Montana]. Retrieved June 9, 2008, from http://factfinder.census.gov; U.S. Department of Commerce, Bureau of Economic Analysis. 2008. *Regional Economic Information System.* Retrieved June 9, 2008, from http://www.bea.gov/regional/reis; and U.S. Department of Labor, Bureau of Labor Statistics. 2008. *Local Area Unemployment Statistics* [for Ravalli County, and Montana]. Retrieved June 9, 2008, from http://www.bls.gov/lau/home.htm

climate lent to the development of smaller farm and ranch units in the Bitterroot than are found in most locations in the state. Also, from 1910 to 1920, a substantial portion of the valley was subdivided into orchard tracts. Although most orchards were ultimately unsuccessful, one of their legacies was the existence of hundreds of small parcels already prime for rural ranchettes.

The valley was predominately agricultural, with a small amount of logging and mining, until the 1970s. As of 1960, for example, over 110,000 acres in the Bitterroot drainage (including Missoula County) were identified by the State Engineer's office as being irrigated. Most irrigated lands grew forage for cattle, with additional lands in sugar beets and a few irrigated orchards.[67]

Beginning in the 1970s, many of the same features that made irrigated agriculture attractive, combined with proximity to the rapidly growing Missoula urban area, led to increased development pressure in the valley. What were once defined as features that were favorable to irrigated agriculture—numerous small

[67] Montana State Engineers Office. 1958. Water Resources Survey: Ravalli County. Helena, MT.; Montana State Engineers Office. 1960. Water Resources Survey: Missoula County. Helena, MT.

streams, mountain snowpack and a mild climate—were now redefined as amenities that ultimately caused conflicts for irrigated agriculture.

C. Current Status of Irrigated Agriculture and Infrastructure

While areas of Montana where agriculture is the dominant component of the economy are still exploring ways to expand irrigation, in many western parts of the state, such as the Gallatin Valley and the Bitterroot Valley, the emerging challenge is how to sustain existing levels of irrigation.[68] Irrigated agriculture has helped define the economy and character of most western Montana valleys for well over 100 years. However, irrigated agriculture no longer completely dominates the Bitterroot Valley. Strip developments and rural subdivisions now sit adjacent to irrigated fields for nearly the entire length of the valley. Nonetheless, irrigation continues to occur throughout the Bitterroot: more than 75,000 acres of land were irrigated in 2002.[69]

In 2002, there were a total of 1,441 farms in Ravalli County. They cover approximately 383 square miles of land, or about 16 percent of the total land area in the County. Most are concentrated in the Bitterroot Valley bottomlands. Although the number of farms has increased by about 40 percent since 1987, the total amount of land in farms has decreased by 9,500 acres, a decline of about 3 percent, and the average size of a farm has decreased from 252 acres in 1987 to 170 acres in 2002. The change in average size of farms and the number of farms of various acreages may be the result, at least in part, of larger farms that are being subdivided and sold.[70] The hobby farm is slowly replacing the working farm. Based upon the available numbers, the average size of a farm has decreased by approximately 80 acres. While the number of large farms (greater than 2000 acres) has decreased between 1987 and 2002, the number of small farms (between 10-49 acres) has almost doubled since 1987. Table III-2 presents a summary of these statistics.

The statistics presented in Table III-2 also show an increase the number of large farms and ranches (greater than 2,000 acres) in the valley. This should probably not be interpreted as reflecting a resurgence of traditional agriculture on larger units. A number of the valley's large historic ranches have been bought by

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[68] For more information on the irrigation projects proposed in other parts of the state, see *Technical Memoranda 1.2-1.4 and 2.4.*

[69] U.S. Department of Agriculture, National Agricultural Statistics Service. 2004. *2002 Census of Agriculture: Montana State and County Data.* Volume 1, Geographic Area Series Part 26. Report No. AC-02-A-26. June. Table 10: Irrigation.

[70] Changes in survey methodology may also be responsible for differences in the number of farms. In 2002, the Agricultural Census introduced a method of allocating missed farms at the county level called calibration. The 2002 and 1997 data are calibrated to make them comparable. Calibration adjustments for census years prior to 1997 have not been made. Thus the change in size may also be due to differing sampling methods.

Table III-2. Farm Statistics in Ravalli County from 1987 to 2002

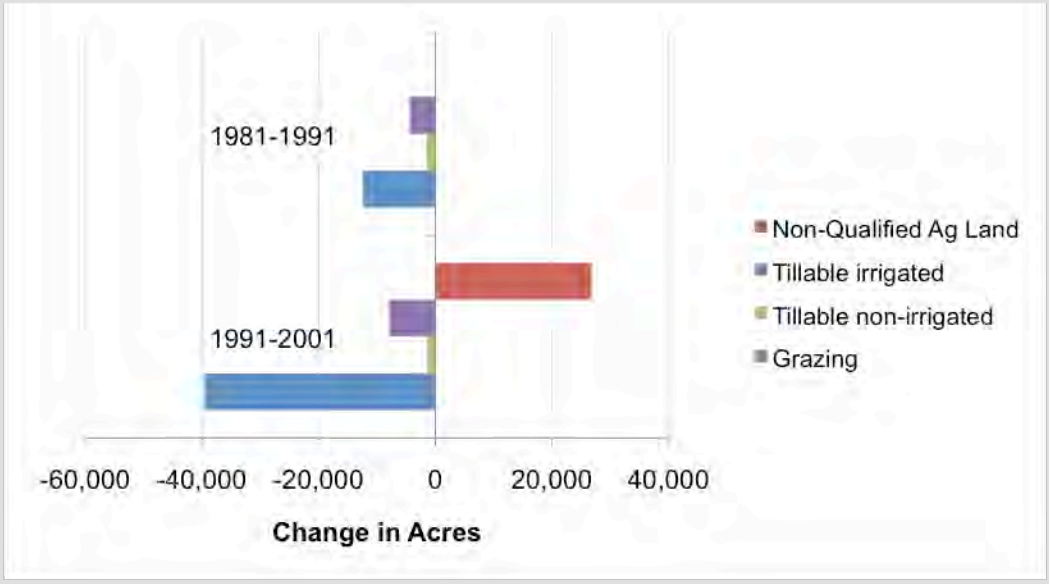
	1987	1992	1997	2002
Number of Farms	1,010	937	1,080	1,441
Land in Farms (acres)	254,761	241,655	183,647	245,133
Average Farm Size (acres)	252	258	170	170
Farms of 10 – 49 Acres	402	404	503	745
Farms of > 2,000 Acres	24	19	12	19

Source: U.S. Department of Agriculture, National Agricultural Statistics Service. 2004. *2002 Census of Agriculture: Montana State and County Data.* Volume 1, Geographic Area Series Part 26. Report No. AC-02-A-26. June.

wealthy out-of-state landowners. These buyers frequently buffer and/or consolidate those acquisitions by buying adjacent properties a well. In combination, there appear to be two trends. A breaking-up of the traditional mid sized farm or ranch in the valley, coupled up with absorption of some of those mid-sized units by adjacent larger properties. Both trends have the effect of reducing the number of mid-sized farms and ranches.

Figure III-6 shows the change in use of agricultural land in Ravalli County between 1981 and 1991, and between 1991 and 2001. Tillable irrigated and tillable non-irrigated acreage both decreased over the last 20 years, but the largest declines in the use of agricultural land came from grazing, which dropped by over 50,000 acres in two decades. The figure shows that non-qualified

Figure III-6. Change in the Number of Acres in Different Agricultural Land Uses in Ravalli County, 1981-2001



Source: ECONorthwest, with data from Swanson, L. 2006. *Growth and Change in the Bitterroot Valley and Implications for Area Agriculture and Ag Lands.* University of Montana, Missoula, O'Connor Center for the Rocky Mountain West. April.

agricultural land increased by almost 30,000 acres between 1991 and 2001. This category of land includes parcels of 20 to 160 acres that have agricultural sales less than $1,500. Essentially, this category describes land that has been taken out of commercial agricultural production.

1. Water Delivery Infrastructure

The major irrigation infrastructure in the valley remains intact and in use, including the storage reservoir at Lake Como (38,500 acre feet) and the associated 60 mile long Big Ditch, which serves over 16,000 acres, as well as the 24,300 acre-feet state-operated Painted Rocks Reservoir on the West Fork of the Bitterroot. In addition, there are several large association ditches on the main stem of the Bitterroot that continue to serve thousands of acres on the east side of the Bitterroot River.

Subdivision and Development in Irrigated Areas. Most of the impacts on irrigated agriculture caused by subdivision have not occurred on the large professionally-managed irrigation projects, but on lands and streams which have been historically managed by individual owners with occasional assistance from court-appointed Water Commissioners.

Irrigation on these individually-managed properties occurs in a very different operating environment than the carefully and efficiently-managed districts, such as the Bitter Root Irrigation District, where water use is tracked and adjusted on a daily basis, with the district itself serving as the coordinator of that use. On streams and ditches where a number of individual water users compete for water without a manager or a management plan, which is commonplace in the Bitterroot, water use can become a matter of "every man for himself." This results in water disputes, unnecessary water use inefficiencies, "out of priority" water use and some historically-irrigated lands being deprived of their water entirely.[71]

Water disputes are not unique to subdivided valleys. However, in more stable agricultural areas, accommodations have often been made over time that serve the interests of most water users, or expectations have become realistic regarding when and how much water might be available. The accommodation might be in the form of a rotation or similar arrangement. The expectation might be the knowledge that water under a particular water right is not available in most years after mid-summer.

The localized water management arrangements that have evolved over the years are often built around the historic farm and ranch units. The knowledge regarding the management arrangements is often passed on from generation to generation. Subdivision and subsequent development of historically-irrigated lands often undermines these past arrangements by "inserting" landowners who

[71] Personal Communication with Don Huls, Ravalli County Right-To-Farm-and-Ranch Chairman. May 28, 2008.

are unaware of historic practices. Subdivision and development of irrigated land also often reconfigures and breaks down historic farm and ranch units into parcels that do not match up well with the historic ditch infrastructure.

Some of the most problematic situations arise within the boundaries of a subdivided historic farm or ranch unit. Water use-decisions that were once vested in a single owner or manager are now made, typically without mutual consultation, by literally dozens of owners of the newly formed ranchettes. Historically, irrigation water may have been moved around the farm or ranch. Now, each ranchette owner wants the water at the same time and for extended durations. A common complaint within subdivided irrigated lands, or on common ditches that serve both subdivided irrigated and intact historic irrigated farms and ranches, is the difficulty in combining the needs of traditional flood irrigators, who need large, but occasional heads of water, with the demands of smaller units which more typically are sprinkler irrigated. Sprinkler irrigation requires a smaller "head" of water, but needs that water on a nearly continuous basis.

Some residents of the valley's subdivided lands are able to irrigate notwithstanding the complications described above. Others lease their land out to nearby farms and ranches, whose operators in turn irrigate the small parcels. However, increasingly smaller parcels, development of previously vacant subdivided lots, and irregular field patterns have all combined to make much of this land difficult and/or unattractive to lease for agricultural purposes. In many cases, residential landowners even offer unused fields for free, but the potential revenues that could be generated from such lands are not sufficient to cover the costs of managing such disparate parcels, and the land remains fallow.

Some steps have been taken to address the problems of subdivision and irrigation proactively. In 2001, Montana's Subdivision and Platting Act (MCA 76-3-504) was amended to address proposed subdivision with lot sizes of 5 acres or less. The amended act provides for, among other provisions, the creation of water users groups, and the establishment of easements for water conveyance facilities and their maintenance.

The amended act codified the distribution of water rights within a subdivision, and has been used in many cases in the Valley. In Ravalli County, a homeowners association is typically established, and that association develops a Master Irrigation Plan. If the subdivision lies within an existing irrigation district, the subdivision falls within that district's rights and the district must approve the plan. If not in an irrigation district, the Ravalli County must approve the plan for maintaining an irrigation distribution system.[72]

Although the amended act appears to have been successful in anticipating the problems associated with relatively high density subdivisions, it does not

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[72] Personal communication with John Lavey, Ravalli County Planner. June 9, 2008.

address the subdivisions comprised of large lots, or the many pre-existing, as yet undeveloped subdivisions in the valley.

One agricultural group in the valley was formed expressly to deal with the impacts of urbanization on local agriculture. The Ravalli County Right to Farm and Ranch group was formed in 1999. Its goals include educating newcomers about the needs and concerns of the remaining agricultural enterprises in the valley, nearly all of which include and are dependent on irrigation. The group also works with government entities to create policies that are friendly to agriculture.[73]

Some, both inside and outside of the agricultural community, believe that zoning may ultimately play a role in protecting the valley's remaining irrigation base. Ravalli County is currently considering several alternative zoning plans. The Right to Farm group has taken a position that is intended to allow farmers and ranchers to subdivide, but with incentives for subdivision plans that concentrate development and preserve farmable and irrigable open space. [74]

A Clash of Urban and Rural Values. A number of irrigators in the Bitterroot Valley describe the difficulties of maintaining and successfully operating irrigated land as stemming from an influx of residents who either do not understand, or simply do not appreciate the Valley's historic irrigated character and the ongoing economic value of that irrigation both in terms of economic activity and land values.

For example, much of the irrigated land in the Bitterroot was and continues to be flood irrigated. In the past, waste water leaving one irrigated property and flowing onto another was commonplace and welcome. However, many of the down-gradient fields now are covered with housing, and up-gradient flood irrigation can create problems, such as wet basements and septic problems..

Another manifestation of the checkerboarding of developed and irrigated land has been the increasing difficulty of accessing infrastructure to maintain ditches and headgates. These structures typically originate off the farm and ranch properties to which they deliver water. Locked gates appear that block traditional access routes. Streamside residential landowners who assume they are "getting away from it all" are surprised to learn they must allow access to irrigators for purposes of checking headgates, clearing them of debris, and cleaning and maintain ditches. Further, new residents may resent reductions in streamflows from irrigation diversions. For the irrigator, the fact that these historical ditches now lie near newly built homes increases liability concerns related to ditch washouts, children falling into ditches and leaky basements.

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[73] Personal Communication with Don Huls, *See* footnote 71.

[74] Personal Communication with Don Huls, *See* footnote 71.

Irrigators often have to police irrigation systems for unauthorized pumps that appear overnight in the ditch now that it flows through a developed area.[75]

The popular conception of rural life is that it is the last refuge of the rugged individualist. Certainly that is one of the motivators for many who move to Montana's rural valleys to experience the "western dream." The reality of rural living is that, in most cases, doing so requires a degree of interaction and accommodation with neighbors that might exceed what is required in urban areas. Irrigation and the shared water and ditch systems that irrigation entails are often how a newcomer is introduced to that fact.

2. Water Use

Irrigation water in Ravalli County is used to produce two primary crops: hay (including alfalfa) and grain. Irrigation water is also applied to pasture for grazing. In 2006, Ravalli County's farmers harvested 26,000 acres of hay, and fewer than 2,000 acres each of wheat and barley.[76] Of the total crops harvested in Ravalli County in 2006, over 90 percent were produced with irrigation. As suggested above, however, traditional irrigation is becoming more difficult and less economic as a result of urban encroachment.

Development of historically-irrigated lands does not necessarily preclude continued irrigation. Except for the cases of more intensive development, rural subdivision often leaves the majority of irrigated lands within the subdivision undeveloped. Much of this formerly irrigated land is now dry, overgrazed, weed infested. ("Too small to farm, too big too mow"). There are thousands of acres that can be characterized in this way in the Bitterroot and similar western valleys, and they comprise an underutilized resource. To a certain extent, this lack of irrigation is a result of some of the cultural and infrastructure obstacles to irrigation that result from subdivision and are briefly described above. However, most obstacles can often be overcome by a small landowner who is determined to continue to irrigate. Perhaps a more fundamental problem is the lack of options beyond the traditional uses for irrigated land in Western Montana, namely hay and pasture. Twenty acres of irrigated hay or pasture is of some benefit to the hobby rancher but not a realistic basis for earning income, or a sufficient incentive to overcome the obstacles to irrigation that exist in subdivided areas.

Smaller parcels do not necessarily preclude productive irrigation. Smaller parcels make possible, in some cases, more intensive management. Several dairies, both traditional and organic, now thrive in the valley. Small scale agriculture is better suited for local markets than national commodity markets. The urbanization of

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[75] Personal Communication with Don Huls, *See* footnote 71.

[76] U.S. Department of Agriculture, National Agricultural Statistics Service. 2008. *Quick Stats – County Data (Crops)* [data for Ravalli County, 2007]. Retrieved May 19, 2008, from http://www.nass.usda.gov/QuickStats/

the valley that has fractionalized irrigated fields plus the growth of nearby Missoula have, ironically, combined to create expanded nearby markets for produce raised on the remaining irrigated lands. Truck farms, sod farms, cherry and apple orchards are successfully operating on relatively-small irrigated parcels. Both growers cooperatives and marketing cooperatives have been formed. According to the local extension office, direct sales from producers to consumers increased from $150,000 in 1997 to $650,000 in 2002. Data from 2007 are not yet available, but will likely show a substantial further increase.[77]

The valley has numerous horse-training stables and riding facilities, often with associated irrigated pastures and fields. With an estimated 7,000 recreational horses in the valley (this figure does not including ranch and outfitter horses) demand for horse hay is high. One study suggests that recreation horses generate $5.5 million in economic activity in the Valley per year.[78]

The Role of Water Rights Laws for the Future of Irrigation in the Valley. Montana's water rights laws are likely to play a key role in the future of irrigation on subdivided ranches and farms. Water has not been used on some of the historically-irrigated lands for a number of years. In many cases, the appurtenant water rights, and the easements necessary to exercise those rights, may be determined to have been abandoned.

Recent changes in Montana's water laws and their application will likely increase development pressure on irrigated lands. The Bitterroot Valley, like many Western Montana river systems, lies within a "Closed Basin," a basin in which no new surface water rights can be issued. Recent court decisions have effectively added groundwater appropriations to the category of water no longer available to new appropriations. In order to obtain a groundwater permit for a large groundwater appropriation, it is now necessary to mitigate that appropriation by retiring an equivalent sized existing right. In the Bitterroot, the only existing rights that are sufficiently large to serve as adequate mitigation for most developments are invariably historic irrigation rights.

The implications of the basin closures and the court decisions linking groundwater and surface water are just beginning to unfold. Two likely implications are as follows: first, irrigated lands will become the most attractive land for development because only those lands will have the requisite readily available water rights; second, the market value of the water rights associated with irrigated lands that are not even contemplated for development will rise significantly. These rights can now be sold for use on developable lands that do not already have associated water rights. Under either scenario, irrigated land is

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[77] Personal Communication with Rob Johnson, MUS Ravalli County Extension Agent. May 30, 2008.

[78] Dave Schultz and Associates. 2005. *Agriculture in the Bitterroot Valley: A Social and Quantitative Economic Perspective*. Ravalli County Right to Farm Board.

lost. In the first case, it is directly lost to development, and in the second, it is lost by conversion of historically-irrigated lands to non-irrigated agriculture.

The Bitterroot Basin's closure to new surface water permits, and the recent complications in obtaining groundwater rights, has focused increased attention on historical water rights. Contemporaneously, the Montana Water Court's adjudication of historic water rights is nearing completion on the west side of the Valley.[79] The Valley's west-side tributary streams are the site of many of the subdivision-related water management difficulties. It is possible that the completion of the adjudication in those areas will help resolve some of those issues. The Water Court adjudication of streams on the east side of the Valley, however, is not expected to begin until 2015.

Groundwater. Although irrigation water is primarily drawn from surface sources in the Valley, the use of surface water for irrigation exerts an influence on groundwater, which is an important source of municipal and domestic water. It appears that over the years, irrigation practices have actually increased the level of the water table throughout the Bitterroot Valley, and have helped to recharge the region's aquifers. For example, when irrigation canals fill in the spring, groundwater nearby will typically rise from 5 to 10 feet over that of surrounding areas due to such "leaks." Near Big Ditch (Bitter Root Irrigation District), the groundwater rises 15 feet in some areas.[80] Changes in irrigation practices will likely lead to changes in groundwater levels, affecting the depth and production of the region's rapidly proliferating groundwater wells.

Population growth outside city limits has lead to a proliferation of groundwater wells, and a growing dependence on groundwater for residential water supplies. The number of wells dug in the Bitterroot Valley in the 1970s was 3.5 times that of the previous decade, and the number of wells dug in the 1990s was almost double that of the 1980s. From 1980 to 2000, 8,201 new wells were drilled in the Bitterroot Valley,[81] a vast majority of the total 9,385 wells existing in 2000, as Figure III-7 shows.[82]

Groundwater levels have decreased in recent years, evidenced in part by the fact that wells are being drilled deeper, as Figure III-8 shows.[83] Changes in irrigation management practices are likely contributing to these declining levels, in combination with increased groundwater withdrawals for residential and

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[79] Montana DNRC 2004. *Adjudication Status Report*. Retrieved May 30, 2008, from http://dnrc.mt.gov/wrd/water_mgmt/clarkforkbasin_taskforce/pdfs/chapter_8.pdf

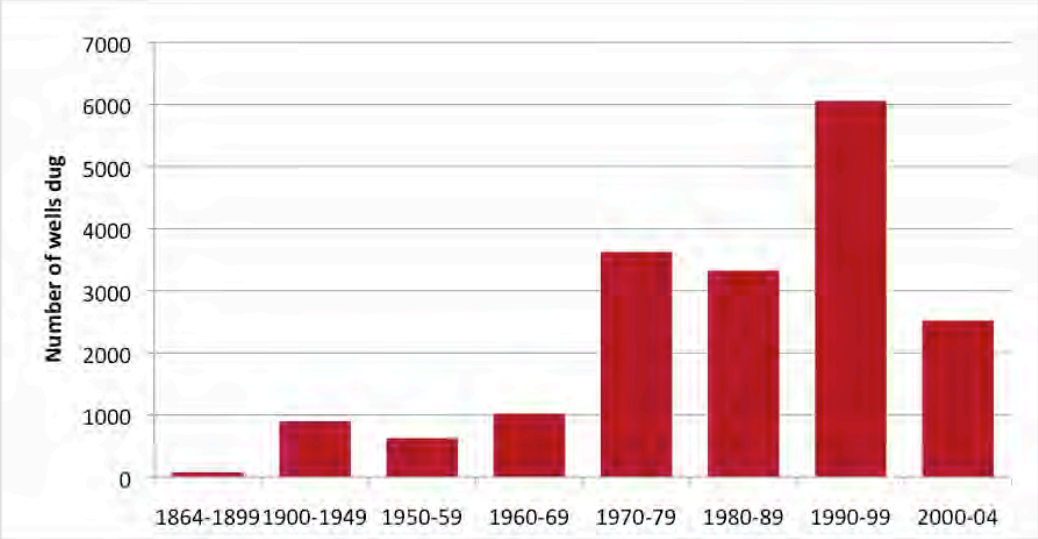
[80] Bitterroot Water Forum. 2003. *Taking care of the Bitterroot Watershed: A Citizen's Guide*. Bitterroot Conservation and Development Area. Hamilton, MT.

[81] Bitterroot Water Forum. 2003. *See* footnote 780.

[82] Groundwater Information Center (GWIC). 2005. *Montana Bureau of Mines and Technology Website*. Retrieved February 4, 2005, from http://mbmggwic.mtech.edu/

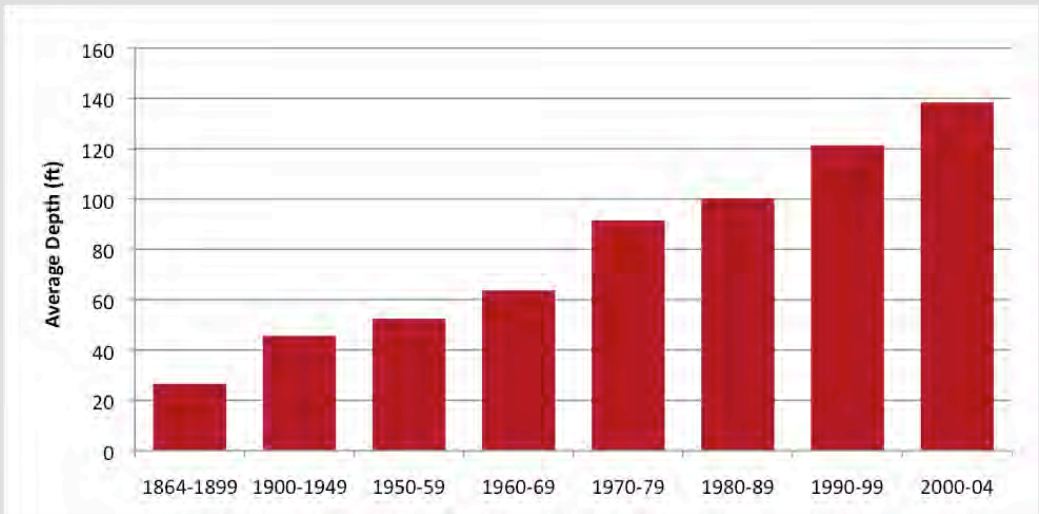
[83] Groundwater Information Center (GWIC). 2005. *See* footnote 82.

Figure III-7. Number of wells dug between 1864 and 2004 in the Bitterroot Valley



Source: Groundwater Information Center (GWIC). 2005. *Montana Bureau of Mines and Technology Website*. Retrieved February 4, 2005, from http://mbmggwic.mtech.edu/

Figure III-8. Average depth of wells drilled in the Bitterroot valley between 1864 and 2004



Source: Groundwater Information Center (GWIC). 2005. *Montana Bureau of Mines and Technology Website*. Retrieved February 4, 2005, from http://mbmggwic.mtech.edu/

municipal use, the increase in well depth may also reflect more building in the foothills where the water table is lower, and/or improved drilling equipment that allows for deeper drilling.

Declining groundwater levels are occurring in part due to reduction in overall irrigation, as well as increasing irrigation water-use efficiency. As farmers

convert from flood irrigation to sprinkler irrigation, line ditches, and cease irrigating areas altogether, aquifers will likely decrease in size, lowering the water table. This, in combination with drought and continued groundwater withdrawals from wells, will probably result in noticeably deeper groundwater levels in the future in the Bitterroot Valley.

Irrigation and Water Quality. Although there is reason to believe that irrigation has historically increased groundwater availability in the Valley, the extent and importance of irrigation in that regard has not yet been quantified. Similarly, to the extent that irrigation affects groundwater levels, it may also be a factor in the groundwater quality issues that are emerging as a result of urban encroachment.

As the Bitterroot Valley population grows, the number of septic systems has increased and so has the potential for contaminants in groundwater. From 1980 to 2000, 9,222 new septic systems were dug in the Bitterroot Valley.[84]

Buffer zones are required around septic systems to allow for dilution of contaminants in the groundwater. Land parcels are classified by contamination hazard levels based upon the density of septic systems. Low hazard is less than 50 septic systems (125 people) per square mile. High hazard is considered to be a density greater than 300 septic systems (750 people) per square mile. Between 1990 and 2000, the number of acres with medium hazard densities of septic systems almost doubled, particularly around the towns of Florence and Lolo, from 22,759 acres to 41,749 acres.[85]

To the extent irrigation infrastructure and irrigation practices affect groundwater levels, the significant increase in septic systems in the valley could create conflicts for irrigated agriculture.

D. Proposed or Recent Investments

The infrastructure associated with the Bitter Root Irrigation Project is over 100 years old, and much of it is in need of rehabilitation. The Irrigation District faces costs in the multi-millions of dollars to upgrade and rehabilitate the structures, including a siphon, pipes and ditches, bridges, and inlet and outlet structures. The District recently raised fees to help fund some of the needed work, but it expects that fees alone will be insufficient to cover all of the expected future expenses.[86] The district replaced Como Dam in 1990, and continues to pay down the debt it incurred during that project, which reduces its ability to raise further funds for new projects.

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[84] Bitterroot Water Forum. 2003. *Taking care of the Bitterroot Watershed: A Citizen's Guide*. Bitterroot Conservation and Development Area. Hamilton, MT.

[85] Natural Resource Information System (NRIS). 2005. Bitterroot Water Forum Data webpage. http://maps2.nris.state.mt.us/mapper/ Accessed February 4, 2005.

[86] Gallob, J. 2008. "Big Ditch Deterioration." *Ravalli Republic.* May 9. Retrieved June 9, 2008, from http://www.ravallirepublic.com/articles/2008/05/09/news//news62.txt

In addition, the Bitterroot River channel from Hamilton to Stevensville is very active and unstable in many locations. Several large irrigation companies's that serve some of the valley's best remaining farmlands have diversions on this reach of the Bitterroot. The companies have spent significant funds in recent years to maintain functional diversions and sustain an adequate flow of water.

Another recent infrastructure issue affecting valley irrigators is the maintenance and safety of the many high mountain storage reservoirs located in the Selway-Bitterroot Wilderness area on the west side of the valley. The remote locations of these reservoirs, coupled with access restrictions, have made maintenance and rehabilitation of these structures, many of which date back to the late 19th century, quite costly. Many of the areas served by water from these high mountain reservoirs have been subdivided. The lack of productive agriculture on these lands often makes these costs more difficult to bear.

E. Goods and Services Affected by Irrigation

1. Primary Goods and Services

In theory, the application of irrigation water to crops produces economic benefits in two ways: by increasing the yield of a crop that was previously cultivated without irrigation, or by enabling a farmer to grow a higher-valued crop. The benefit provided by irrigation shows up in the net farm income a farmer is able to earn from the crop, which is also translated into the value of irrigated land. In practice, in the Bitterroot Valley, development pressures and amenity-driven growth have introduced factors that complicate this dynamic: irrigation may allow a farmer to produce higher yields, or grow higher-valued crops, but it also may provide an attractive opportunity for a developer looking to purchase property and subdivide it into ranchettes.

Net Farm Income. Of the total crops harvested in Ravalli County in 2006, over 90 percent were produced with irrigation. In total, crops brought in receipts totaling about $11.7 million in 2006. This represented about a third of all cash receipts from agricultural products, which totaled almost $34 million in 2006. Cash receipts from livestock and their products totaled approximately $22 million. Excluding government payments, the income farmers received from their production (livestock and crops) was not sufficient to cover their expenses. Including government payments (which totaled $257,000 in 2006) and other sources of income (the value of home consumption, machine hire, and custom work), the net farm income in Ravalli County was still insufficient to cover production expenses in 2006. This is not an uncommon occurrence: the net income of farms in Ravalli County was negative in 7 of the last 11 years.[87] This is consistent with data from the Agricultural Census. In 2002, just 31 percent of

[87] Swanson, L. 2006. *Growth and Change in the Bitterroot Valley and Implications for Area Agriculture and Ag Lands.* University of Montana-Missoula, O'Connor Center for the Rocky Mountain West. April. Retrieved May 19, 2008, from http://crmw.org/read/Downloads/BRLT/Parts1-4.pdf

farm operators in Ravalli County reported net gains in farm income.[88] All of this suggests that for many farms in Ravalli County, agricultural production is not a profitable venture, serving instead as a consumption activity subsidized by off-farm earnings. Many farmers probably continue to farm for reasons other than profit: they value the quality of life it provides, and for some, want to maintain history and tradition.

Land Values. Land prices in Ravalli County and the Bitterroot Valley suggest that many people purchase property for purposes other than, or in addition to, agriculture. The per-acre value of agricultural land exceeds any realistic rate of agricultural return. Instead, property appraisers familiar with this area say that the value of land in the Bitterroot region, particularly on the valley floor where traditional agricultural uses once dominated, is driven by its potential for development. The factors that influence this value include water rights as well as location, access to utilities, and the quality of the property's amenities, such as views or proximity to water. Generalizing the proportion of value contributed by irrigation is difficult in such a market.[89]

For properties purchased for purposes other than agriculture, such as development or recreation, irrigation water rights may add value but the amount of value will vary widely depending on the property and the nature of the water rights. In concept, just as irrigation provides added value to land in an agricultural context because a farmer can earn more revenue from it, it provides goods and services that those purchasing land for recreational or amenity purposes might value more highly (e.g., lush green pastures, the ability to grow alfalfa to feed horses, and running water in small streams or irrigation canals). In practice, however, many people buying land for purposes other than agriculture view a property with irrigation infrastructure as a nuisance, or do not want to be burdened with the management that is required for operating an irrigation system. Many residents of the Bitterroot lease out irrigated land to neighbors to grow alfalfa, or allow nearby farmers to use the land for free. In general, leases run at most $70 per acre, which is often not sufficient to cover the costs of maintaining the system, especially if the land is served by Bitter Root project water, for which the landowner must may monthly fees to the irrigation district.[90] Finding a farmer who is interested in leasing land to farm may also be difficult, especially if the property is small and not adjacent to existing agricultural operations.

In summary, all things equal, irrigation probably does add value to land in the Bitterroot area. However, determining the influence of access to irrigation on the

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[88] U.S. Department of Agriculture, National Agricultural Statistics Service. 2004. *2002 Census of Agriculture: Montana State and County Data*. Volume 1, Geographic Area Series Part 26. Report No. AC-02-A-26. June.

[89] Personal Communication with Paraic Neibergs, Appraiser, Normal Wheeler and Associates. May 28, 2008.

[90] Personal Communication with Paraic Neibergs, *see* footnote 89.

value of land in the region is not straightforward, and will vary considerably depending on the property.

2. Complementary Goods and Services

Quality of Life. The Bitterroot Valley has experienced such impressive growth in recent years, precisely because people are drawn to the pastoral landscapes irrigation helps to create. These landscapes serve as an amenity every bit as attractive as the area's mountains, rivers, lakes, and forests. As fewer farmers irrigate pastures and crops, and more farmland is lost to development, the values associated with these amenities will be lost.[91] Economists often refer to these as consumption amenities because they directly improve the well-being of people who consume them as they live, work, and visit nearby. To the extent that residents derive a net economic benefit, or consumer's surplus, from their proximity to these amenities, this net benefit increases their overall economic well-being. The value of maintaining the quality of life derived from the open spaces and agricultural land to the residents of Ravalli County is evidenced in part by the fact that in 2006, the County's voters elected to spend $10,000,000 to protect farmland and open space.[92] Collectively, the area's residents were willing to pay at least that much to ensure that some agricultural land and open space remain in the region. In addition, 27,000 acres of land in the valley are already in conservation easements, although the percentage of that which is irrigated land is not known. As more acres of agricultural land are lost to development, the value of the remaining acres will increase. Eliminate enough irrigation and the open space on which it occurs, and an important element of the Valley's appeal will be lost, diminishing the quality of life of its current and future residents.[93]

Recreation. The infrastructure built to sustain irrigation in the Bitterroot Valley also provides opportunities for recreation. Two reservoirs were built in the county to provide irrigation water to Bitterroot irrigators: Lake Como and Painted Rocks Reservoir. Painted Rocks is a popular State Park in the region, and Lake Como is a popular destination for fishing. Visitors to both sites can fish, camp, and boat. In 2004, the last year for which data were available, Painted Rocks Reservoir State Park supported almost 11,000 visits.[94] Fishing use data from Montana Fish, Wildlife, and Parks (FWP) indicates that about 2,000 of those

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[91] Swanson, L. 2006. *See* footnote 87.

[92] Trust for Public Land. 2008. *Conservation Almanac: Montana LandVote Data.* Retrieved May 20, 2008, from http://www.conservationalmanac.org/

[93] Gallob, J. 2008. "Brothers See Zoning as a Way to Preserve Ag." *Ravalli Republic.* April 8. Retrieved May 20, 2008, from http://www.ravallirepublic.com/articles/2008/04/08/news/news03.txt

[94] Montana Fish, Wildlife, and Parks, Montana State Parks. 2005. *Visitation Report 2004: Montana State Parks and Fishing Access Sites.* February.

visits were by anglers.[95] As a fishing access site, Lake Como supported almost 6,000 angling days in 2005.[96] Research conducted in the region suggests that the net economic value of fishing in Bitterroot area lakes is $115 per day.[97] Another study of recreation on the Bitterroot River indicates that non-anglers are willing to pay $88 per day of water-based recreation.[98] Using these values, we estimate that the net economic value of recreation at Painted Rocks Reservoir is over $1,000,000 per year, and the net economic value of fishing at Lake Como is almost $700,000 per year.

In addition, water stored in both Painted Rocks Reservoir and Lake Como has been acquired by Montana Department of Fish Wildlife and Parks. This water was acquired for release into the Bitterroot River to augment late-season flows and to enhance the fisheries downstream of the reservoirs. Painted Rocks water in particular is a critical source of downstream flows in the mainstem of the Bitterroot during low-water periods. Some of this flow is specifically earmarked for benefitting the fishery. Other flows released from the reservoir for irrigation purposes have a de-facto benefit to the fishery in the reaches of the river lying between Painted Rocks Reservoir and irrigators' headgates.

Another unique feature of the infrastructure associated with irrigation in the valley is the large number of high mountain lakes located in the Bitterroot Mountains. Many of these lakes were modified by irrigators, typically at the end of the 19th century, to provide late season irrigation water. Water released from these reservoirs provides late season water and enhances fisheries in numerous small streams in the valley.

Aquifer Recharge. Irrigation, especially flood irrigation, has helped keep many of the aquifers in the valley recharged, sustaining the domestic wells that support much of the new residential growth outside of incorporated areas in the Bitterroot Valley.[99] Should irrigation cease or become more efficient, allowing less water to seep into the aquifers, residents who rely on these wells may have to develop alternative sources of water, or drill deeper wells.

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[95] Montana Fish, Wildlife, and Parks. 2008. *Montana Fishing Guide: Painted Rocks Reservoir.* Retrieved May 20, 2008, from http://fwp.mt.gov/fishing/guide/q_Painted_Rocks_Reservoir__1136928457754.aspx

[96] Montana Fish, Wildlife, and Parks. 2008. *Montana Fishing Guide: Lake Como.* Retrieved May 20, 2008, from http://fwp.mt.gov/fishing/guide/q_Lake_Como__1144447460884.aspx

[97] Duffield, J., J. Loomis, and R. Brooks. 1987. *The Net Economic Value of Fishing in Montana.* Montana Department of Fish, Wildlife, and Parks. August. We have converted the values to 2007 dollars.

[98] Duffield. J.W., C.J. Neher, and T.C. Brown. 1992. "Recreation Benefits of Instream Flow: Application to Montana's Big Hole and Bitterroot Rivers." *Water Resources Research* 28(9): 2169-2181.

[99] Bitter Root Resource Conservation & Development Area, Inc. 2002. *Comprehensive Economic Development Strategy & Bitter Root Resource Conservation & Development Area Plan for Missoula, Mineral, and Ravalli Counties.* July.

Riparian Habitat. Irrigation canals and drainage ditches provide additional riparian habitat in the Bitterroot Valley that benefits many species, including migratory birds, waterfowl, and small and large mammals. In addition to the inherent value provided by the ecosystem services associated with this habitat, the habitat also provides residents and visitors with more opportunities to watch wildlife and hunt, both economically valuable activities in the region.

3. Competing Goods and Services

Fish and Wildlife Habitat. Montana FWP has identified 77.5 miles of chronically dewatered streams in the Bitterroot watershed.[100] Irrigation withdrawals and impoundments contributed to reduced flows in most, if not all of these streams. Decreased instream flows place stress on fish and their habitat, especially for cold-water species found in the Bitterroot and its tributaries, by raising temperatures, reducing dissolved oxygen levels, and lowering pool levels that provide important habitat.[101] Irrigation may also negatively impact fish if they become entrained in ditches and canals, which happens when the infrastructure is not protected with fish screens. In one tributary to the Bitterroot River, researchers found that both adult and juvenile westslope cutthroat trout become trapped and died in irrigation canals on the creek, and in 2003, over a quarter of the juvenile cutthroat moving downstream were entrained in one unprotected canal.[102] At least two species in the Bitterroot River are protected to ensure they do not become extinct: the bull trout is a federally listed threatened species, and the westslope cutthroat trout is a species of special concern in Montana.[103] Irrigation's impacts on endangered, threatened, and other sensitive species create costs for society if they reduce populations and adequate habitat, increasing the risk of extinction. A survey of studies that measure household's willingness to pay to ensure the continued survival of certain species found that households in the U.S. would be willing to pay a one-time amount of $19 to ensure the continued survival of cutthroat trout.[104] To the extent that the Bitterroot Valley's

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[100] Montana Fish, Wildlife, and Parks, Fisheries Division, Water Program. 2003. *FWP Dewatering Concern Areas.* May. Retrieved May 21, 2008, from ftp://ftp-fc.sc.egov.usda.gov/MT/www/programs/eqip/DewateredStreams.pdf

[101] Montana Department of Environmental Quality. 2005. *Water Quality Restoration Plan and Total Maximum Daily Loads for the Bitterroot Headwaters Planning Area.* October. Retrieved May 21, 2008, from http://www.deq.state.mt.us/wqinfo/TMDL/BitterrootHeadwaters/FinalBitterrootMaster.pdf

[102] Gale, S.B. and A.V. Zale. 2005. *Evaluation of Entrainment Losses of Westslope Cutthroat Trout at Private Irrigation Diversions and the Efficiency of Fish Screens on Skalkaho Creek, Montana.* Montana State University-Bozeman, Montana Water Center, Wild Fish Habitat Initiative. January.

[103] Montana Fish, Wildlife, and Parks. 2008. *Montana's Species of Concern.* Retrieved May 21, 2008, from http://fieldguide.mt.gov/detail_AFCHA02088.aspx

[104] Loomis, J.B., and D.S. White. 1996. "Economic Benefits of Rare and Endangered Species: Summary and Meta-Analysis." *Ecological Economics* 18(1996): 197-206. We have adjusted the value to 2007 dollars.

tributaries serve as an important key to the survival of the species, the value of protecting these resources could be considerable.

Recreation. Residents and visitors from other places in Montana and from out of state enjoy the Bitterroot River and its tributaries for the recreational opportunities they provide. The Bitterroot River is a "red-ribbon" wild trout fishery that supported over 100,000 fishing days in 2005—one of the most popular fishing destinations in the region.[105] Many people also flock to the river to swim, float, and hike and picnic along its banks. Research shows that river levels influence the level of participation in river-based recreation, as well as the quality of recreationists' experiences. Lower flows typically translate into lower-quality and lower-valued recreation. Researchers measured the recreational benefits of additional instream flow on the Bitterroot River, and found that during low-flow periods, the marginal value of an additional acre-foot of water in the river for recreation is almost $16.[106] During periods of high flow, recreationists are less willing to pay for additional water. This research suggests that there are trade-offs in the Bitterroot Valley between irrigation and recreation, and under certain conditions, water used for instream flows may provide more economic value to the region than water used for irrigation.

4. Trends and Factors Influencing Goods and Services

As Figure III-1 at the beginning of this case study shows, the population of the Bitterroot Valley is expected to continue its rapid growth over the next few decades. As this happens, conflicts over the Valley's water will increase in frequency and intensity. This, in combination with other factors, including climate change, and decisions related to water rights, will affect the levels of goods and services associated with irrigation in the Bitterroot Valley in years to come.

In recent years, land use planning and zoning processes, and a county-wide passage of a bond measure to create a fund to protect farmland and open space indicate a collective recognition of the importance of agriculture to the prosperity of the region. However, the region faces inevitable tension between protecting agricultural land for its amenity value—people like the way it looks—and maintaining the viability of irrigated production agriculture. Throughout this case study, we have highlighted many of the challenges that emerge when agricultural operations are replaced by recreational and hobby farms and ranchettes—especially challenges related to maintaining irrigation infrastructure and coordinating irrigation water management among many different land owners, with diverse values and priorities. The decisions and strategies adopted

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[105] Montana Fish, Wildlife, and Parks. 2008. *Montana Fishing Guide: Bitterroot River*. Retrieved May 21, 2008, from http://fwp.mt.gov/fishing/guide/q_Bitterroot_River__1141176468612.aspx

[106] Duffield. J.W., C.J. Neher, and T.C. Brown. 1992. "Recreation Benefits of Instream Flow: Application to Montana's Big Hole and Bitterroot Rivers." *Water Resources Research* 28(9): 2169-2181.

in the next few years related to zoning and irrigation system management will likely determine how agriculture and urban development coexist in the Valley for the next generations of irrigators.

Climate change also is likely to affect the level of goods and services provided by the region's water, in several ways. First, higher temperatures will increase demand for water from irrigators, as well as residential customers, and the fish and wildlife species that depend on cool flows for their survival. At the same time, climate change will reduce the supply of water in the region, particularly during the spring and summer irrigation season. The Bitterroot River and its tributaries are dependent on melting snowpack for much of their flows throughout the spring and summer, and climate change is expected to have a considerable impact on these kinds of streams, as higher temperatures reduce snowpack. Already between 1950 and 2000, the water content found in the snowpack of the Bitterroot Mountains on April 1 has declined by around 30 percent.[107] This increase in demand for the region's water and decrease in supply will heighten the competition among water users, and decrease the overall level of goods and services the region's water is capable of producing.

Finally, the status of the Bitterroot as a basin closed to new appropriations of both surface and groundwater will increase competition for the basin's existing water rights and continue to reduce the supply of irrigated land. Developers, which now must compete with irrigators for the same water rights, will reduce the supply of irrigated land in the Bitterroot Valley by directly converting irrigated land, and by purchasing irrigation water rights to provide drinking water to new developments.

F. Summary and Expectations for Future Investments

The major questions facing the Bitterroot Valley's residents in the years to come are whether to sustain irrigated agriculture in the region, and if so, how. Irrigators throughout the Valley are facing considerable challenges, as the region is experiencing a major structural shift away from an economy based on natural-resource extraction and agricultural production, towards an amenity-driven economy.[108] The rapid population growth and land development of the last few years has directly and indirectly put pressure on irrigated agriculture, in several ways:

- Agricultural land, especially irrigated land, is being converted to residential and commercial development. As water supplies grow increasingly scarce, irrigated land may be chosen preferentially for new development if it has secure, high-priority water-rights.

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[107] Stewart, I.T., D.R. Cayan, and M.D. Dettinger. 2005. "Changes Toward Earlier Streamflow Timing Across Western North America." *Journal of Climate*. 18: 1136-1155. Retrieved May 27, 2008, from http://meteora.ucsd.edu/cap/pdffiles/stewart_clch.pdf

[108] *See,* for example, Swanson, L. 2006. *See* footnote 87.

- The Basin's closure to new appropriations of both surface and groundwater has resulted in developers looking to agriculture to acquire new residential water supplies. By transferring water rights from irrigation to domestic purposes, development may increase the amount of irrigated land being converted to dry-land crops or being taken out of production altogether.

- Subdivision of irrigated farms has broken down traditional systems for managing irrigation water. Traditional rights-of-way for infrastructure maintenance are cut off, ditches do not always conform to new property boundaries, more individual farms compete for the same water at the same time, and the water delivery needs of traditional flood irrigators conflict with the needs of sprinkler irrigators.

As a result of these factors, water is used less efficiently than it otherwise would be. In addition, much of the irrigation infrastructure in the Valley is over 100 years old, and is in need of rehabilitation. The challenges of securing the necessary funding may become overwhelming, especially when historical ownership and maintenance responsibilities are thrown into disarray by land subdivisions and new ownership patterns.

Many of the trends and factors influencing goods and services in the Bitterroot Valley may compound these challenges in the future. Population growth is only expected to increase, which will increase the demand for water for municipal uses. At the same time, climate change is expected to increase the demand for water from all sectors, while reducing the supply of water, especially during the irrigation season. The needs of threatened and sensitive fish species in the Bitterroot River and its tributaries have drawn increasing attention from regulators, and, in the face of increased water scarcity, may require a greater proportion of the Valley's water for instream flows to ensure their survival, along with new investments in irrigation infrastructure to prevent the fish from becoming trapped in canals and pumps.

Despite all of these challenges, many of the Valley's residents and irrigators appear to be committed to maintaining irrigated agriculture in the Bitterroot. For many, support emerges from one compelling fact: irrigation generates amenities that enhance the region's quality of life. The pastoral landscapes sustained by irrigation provide the backdrop for which many moved to the area. Demand for irrigation's associated amenities, including wide open spaces and lush green fields, has driven property values to record highs. In any given year, the net farm income of the majority of the farms in the Bitterroot Valley is negative, which suggests that, on many farms, agriculture represents a consumption activity: people continue to irrigate, harvest fields, and keep animals because of the lifestyle it provides, or to maintain traditions to pass on to future generations. Both production farmers and "hobby farmers" maintain off-farm jobs, or earn income from other sources to sustain this lifestyle. Residents across the valley, many of whom aren't irrigators themselves, are willing to pay to preserve what is widely perceived to be a diminishing resource: in 2006, Ravalli County's

citizens authorized $10 million in funds to purchase agricultural and open-space land to protect it from development.

While much of the irrigated agricultural land that remains in production appears to serve purposes other than providing the primary income to support a household, some irrigators are looking to unconventional agricultural opportunities to allow them to continue farming and irrigating. Farmers are increasingly tapping into local markets, which are expanding with population growth and the mounting popularity of the local-food movement. They are also taking advantage of smaller parcels to practice more intensive, unconventional management strategies.

The consequences of future investments in irrigated agriculture in the region will be influenced greatly by the changing structure of the economy in the Bitterroot, and the competition for water emerging from other sectors of the economy, including residential users and those that utilize water instream for recreation and other purposes. Irrigation generates goods and services in the region, but not necessarily in the same way it has in the past, or does in other regions of the state. Investments in coordinated water management would help move the region towards a more efficient and rational use of irrigation water in the face of a rapidly transforming landscape, reducing conflicts among irrigators and between irrigators and other users.

IV. Case Study 3: Milk River Irrigation Project

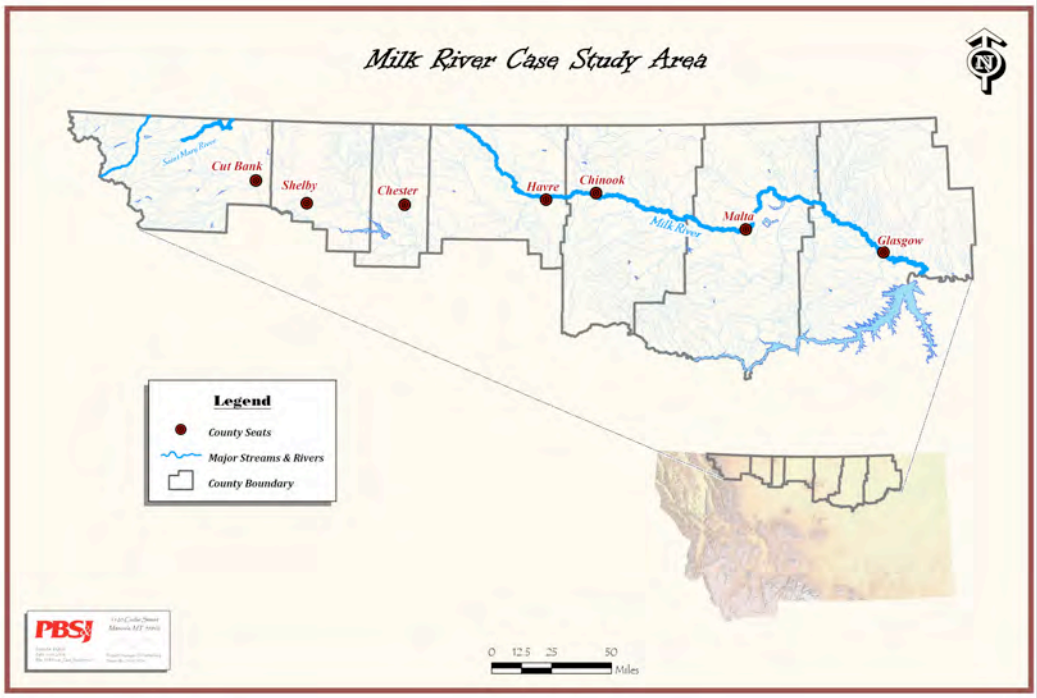
A. Description of the Study Area

1. Study Area Boundaries

The infrastructure of the Milk River Project, which is the primary supplier of irrigation water in north-central Montana stretches from Glacier County in the west to Valley County in the east. The lands irrigated by the project are concentrated east of Havre in the region's three eastern-most counties, Blaine, Phillips, and Valley. The Project's infrastructure provides drinking water and recreational opportunities upstream of the major irrigated areas in Hill County, the county seat of which, Havre, also serves and the regional population center. Therefore, we draw the boundaries of this case study around four counties in north-central Montana: Hill, Blaine, Phillips, and Valley. Figure IV-1 shows a map of the study area.

This area includes the Fort Belknap Indian Reservation, the southwest corner of the Fort Peck Indian Reservation, and the towns of Havre, Chinook, Zurich, Fort Belknap, Dodson, Malta, Saco, Hindsdale, Vandalia, Glasgow, and Nashua. Providing irrigation and related goods and services to an area spread over four counties, which together cover almost 12 percent of Montana, this is one of the most geographically dispersed irrigation projects in Montana, although the irrigation project itself covers only a small portion of the acreage of the four counties.

Figure IV-1. Map of the Milk River Case Study Area



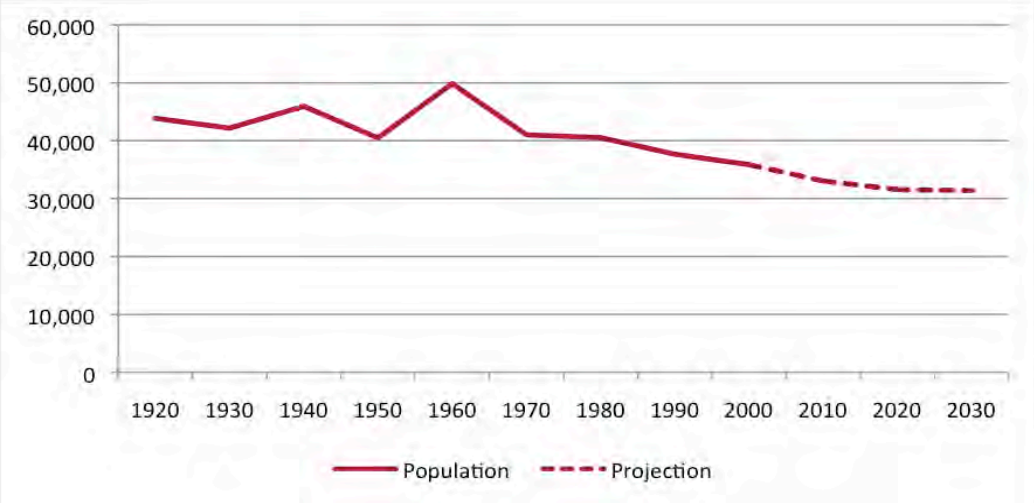
Source: PBS&J.

2. Description of the Region's Population and Economy

Situated in north-central Montana, along the border with Canada, the four-county region is geographically isolated, and more removed from major economic and population centers and transportation corridors than most other regions in Montana. The U.S. Bureau of Economic Analysis associates Blaine, Hill, and Phillips Counties with the economic center of Great Falls, and Valley County with the economic center of Billings.[109]

The four-county region's population was 35,856 in 2000. The population has declined overall during the last half of the twentieth century, as Figure IV-2 shows. The initial declines, during the 1920s and 1940s are likely the result of the first dry-land homesteaders leaving the area after failing to find success with farming, and workers leaving the area after construction of Fork Peck Dam ended. The population increased again during the 1950s following the increased activity at the Glasgow Airforce Base during the cold war. The decline after 1960, is probably a manifestation of the broader rural population decline experienced by communities across the Great Plains during the last half of the 20th century. Today's population is below where it was when the Bureau of Reclamation

Figure IV-2. Population Trend for Blaine, Hill, Phillips, and Valley Counties between 1920 and 2000



Source: ECONorthwest, with data from Forstall, R.L. 1995. *Population of Counties by Decennial Census: 1900 to 1990.* U.S. Department of Commerce, Bureau of the Census. March 27. Retrieved June 5, 2008, from http://www.census.gov/population/cencounts/mt190090.txt and NPA Data Services, Inc. 2007. *Montana Population Projections.* Retrieved June 9, 2008, from http://ceic.commerce.state.mt.us/Demog/project/NPActy_total_and_65+_1107_web.pdf

[109] The U.S. Bureau of Economic Analysis delineates regional markets throughout the country, which it calls Economic Areas. The Areas consist of economic nodes that are centers of regional commerce, and the surrounding counties that are economically related to the nodes. Montana is divided into four Economic Areas: Great Falls, Billings, Helena, and Missoula. Blaine, Hill, and Phillips Counties are part of the Great Falls Economic Area, while Valley County falls into the Billings Economic Area.

developed much of the irrigation infrastructure of the Milk River Project, and is expected to continue to decline, as the dashed line in Figure IV-2 indicates.

As the total population declines, it is also aging faster than state and national averages. In many parts of the region, the population is older than Montana as a whole and the percent of the population over 65 is greater than the statewide percent. See Table IV-1, below, for more details.

The per capital personal income in 2006, the last year for which data were available, ranged from $21,100 in Blaine County to $31,950 in Hill County. The bottom end of this range falls well below the per capital personal income for the as a whole, which was $30,790 in 2006. The percentage of the population living below the poverty level in the region exceeded the state average of 13.6 percent: 21.5 percent of the population was below the poverty level in Blaine County, 18.4 percent in Hill County, 15.5 percent in Phillips County, and 13.8 percent in Valley County. These relatively high numbers are likely influenced upwards by the Indian Reservations in the region, which have high concentrations of people living below the poverty level: the Rocky Boys Reservation is located in Hill County, the Fort Belknap Reservation spans Blaine and Phillips Counties, and the Fort Peck Reservation is located in the eastern portion of Valley County.

The unemployment rate for the three-county region has fluctuated over the last two decades, but in recent years has leveled off, and remains at or below the annual average for Montana. Figure IV-3 shows the trend in the annual unemployment rate for Blaine, Hill, Phillips, and Valley Counties, and for Montana. While the total unemployment rate in the region in recent years mirrors the rate for the state, pockets of exceptionally high unemployment continue to be problematic for parts of the region, especially on the Reservations. For example, the unemployment rate in Roosevelt County is influenced by high unemployment rates reported on the Fort Peck Indian Reservation. Officially, the U.S. Census Bureau estimated in 2000 that the unemployment rate on the Reservation was 10.9 percent, and the Montana Department of Labor and Industry estimated a rate of 9.9 percent in 2006.[110] However, the U.S. Bureau of Indian Affairs estimated an unemployment rate of 54 percent in 2005 among enrolled members of the tribes that live on the Reservation.[111]

Agriculture has historically represented, and continues to represent, the major industry in the region. Government (federal, state, and local government) employment in 2006 made up almost 20 percent of total employment. Farm employment was the next largest employer, at 14 percent. Ten percent of the

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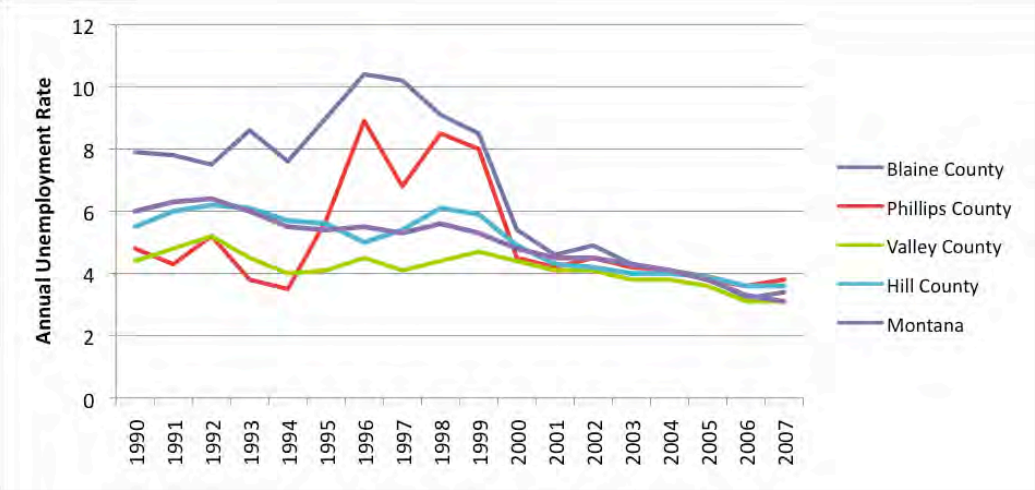
[110] Montana Department of Labor and Industry, Research and Analysis Bureau. 2008. Montana Reservation Labor Force Statistics: 2006 Annual. Retrieved May 14, 2008, from http://www.ourfactsyourfuture.org/?PAGEID=67&SUBID=220

[111] U.S. Department of the Interior, Bureau of Indian Affairs. 2007. *Bureau of Indian Affairs Calculation of Unemployment Rates for Montana Indian Reservations.* Retrieved May 14, 2008, from http://www.ourfactsyourfuture.org/admin/uploadedPublications/1935_IndianLaborMarket_wCSK.pdf

Figure IV-3. Average Annual Unemployment Rate For Blaine, Hill, Phillips, and Valley Counties and Montana, 1990-2007



Source: ECONorthwest, with data from U.S. Department of Labor, Bureau of Labor Statistics. 2008. Local Area Unemployment Statistics [for Blaine, Hill, Phillips, and Valley Counties, and Montana]. Retrieved May 1, 2008, from http://data.bls.gov/PDQ/outside.jsp?survey=la

IV-4. Employment by Industry in the Region, 2006

Source: ECONorthwest, with data from U.S. Department of Commerce, Bureau of Economic Analysis. 2008. *Regional Economic Information System: Table CA25.* Retrieved May 6, 2008, from http://www.bea.gov/regional/reis/CA25Nfn.cfm

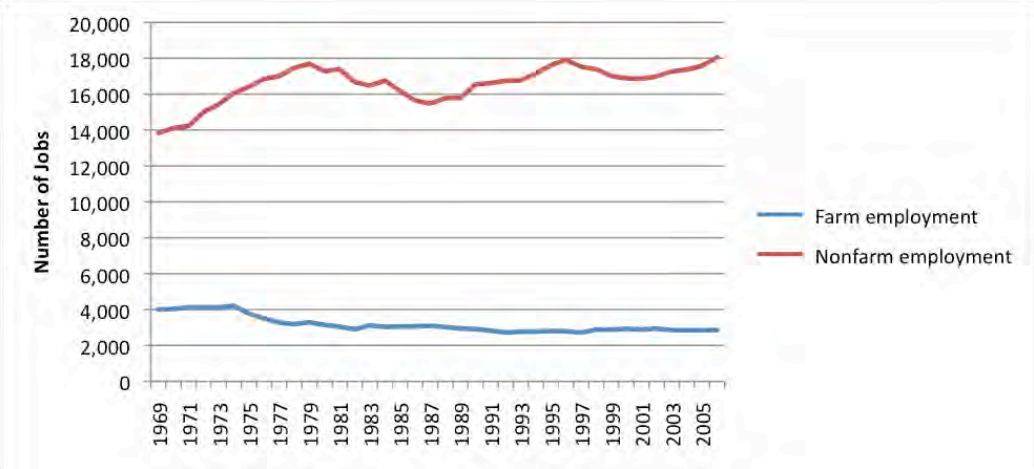
workforce was employed in retail trade, 5 percent in construction, and 2 percent in wholesale trade. The remaining 49 percent of workers were employed in other private enterprises, including professional services, accommodation and food services, transportation, and health care. Figure IV-4 shows this break-down.

Farm employment remained constant between 2001 and 2006, and although the total population of the region declined, total employment actually increased

slightly during the same period, with all of that growth in private, non-farm employment. As Figure IV-5 shows, over the last thirty years, non-farm employment rose during the 1970s, followed by a drop during the early 1980s. The latter 1980s and early 1990s saw further growth, followed again by a dip in non-farm employment in the early 2000s. Levels of non-farm employment were the highest they have been in the last thirty-five years. Farm employment dropped during the 1970s, and has remained constant since the late 1980s.

Personal income from farm sources in the region has fluctuated over the last six years, ranging from a low in 2006 of about $20 million to a high in 2004 of about $63 million (not adjusted for inflation).[112] Although farm employment represents 14 percent of the region's overall employment, the income from farm employment represented a lower percent of total income in the region, ranging from 3.6 percent to 11 percent between 2001 and 2006. While farm income fluctuated widely between 2001 and 2006, non-farm income was steady during the same period.[113]

Figure IV-5. Trends in Non-Farm and Farm Employment in the Region, 1969 - 2005



Source: ECONorthwest, with data from U.S. Department of Commerce, Bureau of Economic Analysis, Regional Economic Information System.

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[112] The Bureau of Economic Analysis' Farm Earnings data is comprised of the net income of sole proprietors, partners and hired laborers arising directly from the current production of agricultural commodities, either livestock or crops. It includes net farm proprietors' income and the wages and salaries, pay-in-kind, and supplements to wages and salaries of hired farm laborers; but specifically excludes the income of non-family farm corporations.

[113] U.S. Department of Commerce, Bureau of Economic Analysis. 2008. *Regional Economic Information System: Table CA05.* Retrieved May 6, 2008, from http://www.bea.gov/regional/reis/CA05Nfn.cfm

Table IV-1. Summary of Demographic and Economic Characteristics of the Population

	Blaine County	Hill County	Phillips County	Valley County	Montana
Demographic Statistics					
Population, 2000	7,009	16,673	4,601	7,675	902,195
Median Age, 2000	34.4	34.5	40.8	41.7	37.5
Percent of population over 65, 2000	12.9%	12.8%	17.6%	19%	13.4%
High School Graduate or Higher, 2000	78.7%	86.8%	82.4%	83.9%	87.2%
Bachelor's Degree or Higher, 2000	17.4%	20%	17.1%	15.7%	24.4%
Economic Statistics					
Per Capita Personal Income, 2006	$21,100	$31,950	$24,230	$30,258	$30,790
Percent Below Poverty, 2004	21.5%	18.4%	15.5%	13.8%	13.6%
Total Employment, 2006	3,155	10,259	2,705	4,793	637,401
Percent Farm Employment, 2006	21%	7%	23%	17%	5%
Unemployment Rate, 2007	3.4%	3.6%	3.8%	3.1%	3.1%

Source: ECONorthwest, with data from U.S. Department of Commerce, Bureau of the Census. 2008. *American Factfinder Fact Sheets* [for Blaine, Hill, Phillips, and Valley Counties, and Montana]. Retrieved June 9, 2008, from http://factfinder.census.gov; U.S. Department of Commerce, Bureau of Economic Analysis. 2008. *Regional Economic Information System.* Retrieved June 9, 2008, from http://www.bea.gov/regional/reis; and U.S. Department of Labor, Bureau of Labor Statistics. 2008. *Local Area Unemployment Statistics* [for Blaine, Hill, Phillips, and Valley Counties, and Montana]. Retrieved June 9, 2008, from http://www.bls.gov/lau/home.htm

B. History of Irrigated Agriculture and Investment in the Study Area

No other irrigated area in Montana that is more dependent on the transfer of water from another river basin, or "imported" water. In its natural state, the Milk River was a prairie stream, the product of a watershed that includes no mountainous, high-precipitation areas. It was called the Milk River by Lewis and Clark because of the milky appearance caused by its high sediment load. Prior to the development of the Milk River project early in the 20th century, even the limited irrigation that occurred in the watershed frequently resulted in a complete de-watering of the stream.[114] Due to the Milk River Project and its associated import of water, however, the Milk is likely the only major river system in Montana whose total volumes actually exceed natural levels as a result of irrigation development.

[114] Personal Communication with Michael Daily, Glasgow Regional Water Resources Office Hydrologist/Planner. May 20, 2008.

This increase in volume exists as a result of the project's diversion of water from the St. Mary River, as that river flows north into Canada from Glacier National Park. The water is diverted into a 29 mile canal/pipeline that carries water from the St. Mary River into the upper Milk River drainage. The Milk then flows into Canada, but returns to Montana at a location northwest of Havre in Hill County, over 200 miles downstream.[115]

The major components of the Bureau of Reclamation's Milk Project include the St. Mary diversion and canal plus three storage reservoirs (Lake Sherburne, Fresno Reservoir, and Nelson Reservoir). The Bureau began construction in 1906, and the Project's major infrastructure was essentially completed in the early 1940s with the development of the Dodson Pump Unit.[116]

As suggested above, some irrigation in the Milk River Valley pre-dates the Milk River project and existed independent of the additional water imported to the basin by the project, most notably the Bureau of Indian Affairs' Fort Belknap Project on the Fort Belknap Indian Reservation. However, although this project has senior rights to use much of the natural flow of the Milk, it also utilizes some of the storage capacity created in Fresno Reservoir by the Milk River Project.[117]

The number of irrigated acres in the Montana portion of the Milk River Basin does not appear to have either increased or decreased in recent years. For example, no additional contracts for irrigation water have been issued by the Bureau of Reclamation since the 1960s.[118] No new water rights permits have been issued on the Milk by the DNRC since 1985. On the other hand, urban encroachment and population growth has not displaced irrigated land in the Milk River Valley as it has in western regions of the state. The area remains predominantly rural and agricultural.

The history of irrigation in the Milk River provides many interesting contrasts with the Greenfields Irrigation District, discussed in the Greenfields Case Study. Greenfields is widely considered to be one of Montana's most successful large-scale irrigation projects. Some believe that one basis for the success of the Greenfields district is the large percentage of grain crops, including malting barley, which is grown there. Greenfields was a farm oriented project from its inception, comprised largely of blocks of newly developed land units generally without ready access to rangelands, and was settled largely by former dryland grain farmers. In contrast, the Milk River was cattle country at the time of the Milk River Project's inception, and most farm and ranch units served by the

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[115] U.S. Department of the Interior, Bureau of Reclamation, Montana Area Office. 2004. *Regional Feasibility Report: North Central Montana.* October. Page 9.

[116] Montana Water Resources Board. 1968. *Water Resources Survey: Phillips County*. Helena, MT.

[117] Personal Communication with Michael Daily. *See* footnote 114.

[118] Personal Communication with Lenny Duberstein, Bureau of Reclamation, Montana Area Office. May 21, 2008.

project were strung out along the Milk River Valley and included adjacent rangelands. Consistent with its origins, irrigation in the Milk has been largely oriented to the growth of hay and forage for use in the context of cattle operations. It is a project largely occupied by ranchers, not farmers.[119]

Relatively little land in the Milk, at least as compared to some similarly sized irrigation projects in Montana, has been used to grow grains or what some economists describe as "high value crops". Until the1970's, sugar beets were an important crop in the Chinook area, initially in conjunction with a sugar refinery located there. However, the refinery closed, and although sugar beets where then shipped to a Billings refinery for a period, eventually shipping costs made sugar beets uneconomical.[120]

Other alternatives to irrigating forage crops are still explored in the Milk however, including seed potatoes, malting barley, organic grain crops, grass seeds and new varieties of corn and soybeans suited for the Milk's short growing season.[121] There has also been some recent experimental production of carrots and dry beans. However, although alternatives continue to be explored, forage crops comprise 85 percent of the irrigated acres along the Milk.[122]

C. Current Status of Irrigated Agriculture and Infrastructure

1. Water Delivery Issues and Infrastructure

The Bureau of Reclamation's Milk River Project contains three divisions that are made up of eight irrigation districts. The Chinook Division districts include the Fort Belknap (similarly named but distinct from the BIA's irrigation project), Alfalfa Valley, Zurich, Paradise Valley, and Harlem Districts; the Malta Division includes the Malta and Dodson Districts; and the Glasgow Division includes the Glasgow District. Together these Districts provide water to irrigate 98,777 acres on 660 farms and ranches.[123] In addition to the Districts, the Milk River Project

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[119] Personal Communication with Randy Reed, Chinook area farmer. June 2, 2008.; Personal Communication with Steve Page, Glasgow area rancher. June 2, 2008.; Personal Communication with Larry Mires, St. Mary Rehabilitation Project Executive Director. June 2. 2008.

[120] Personal Communication with Randy Reed, Chinook area farmer. June 2, 2008.; State Water Conservation Board. 1967. *Water Resources Survey: Blaine County*. Helena, MT.

[121] Personal Communication with Randy Reed. *See* footnote 119.

[122] Personal Communication with Lenny Duberstein. *See* footnote 118.

[123] Personal Communication with Jennifer Brandon, Milk River Joint Board of Control Program Manager. June 3, 2008.

provides irrigation water on a contract basis to private farms and ranches irrigating about 11,529 acres.[124]

The linchpin of the Milk River Project is the St. Mary diversion and canal. This system historically conveyed up to 850 CFS from the St. Mary River across a low divide into the Milk River drainage. The St. Mary River originates in high elevation, relatively high precipitation lands of Glacier National Park, and flows across the Blackfeet Reservation north into Canada and into Hudson Bay. Coupled with an upstream storage reservoir at Sherburne Lake (68,080 acre feet of storage), and the downstream (Milk River) Fresno (108,000 ace feet of storage) and Nelson (79,224 acre feet of storage) Reservoirs, the St. Mary Diversion provides all of the project water in an average year, and usually 70% of Milk River flows at Havre. Overall, in an average year, 50% of irrigation season flow is provided by the diversion, and as much 90 percent of irrigation season flow during drought years.[125,126] In addition to being limited, the natural flow of the Milk is generally not available to the project due to the existence of competing senior water rights, particularly the rights held by the BIA's Fort Belknap Project

The threats to irrigation in the Milk River Project are well known and well documented.[127] Deterioration of the St. Mary diversion and canal has reduced the amount of water that can be transferred into the Milk. The original design capacity of the diversion and conveyance system was 850 CFS. Currently, diversions cannot safely exceed 600 CFS. This difference represents a potential daily reduction of water available to the project of 500 acre feet per day. Further deterioration or major failures along the system could cause further reductions in flow, and even a complete system shut down.[128]

Other uncertainties regarding future water availability stem from the federal reserved water rights of the Fort Belknap, Rocky Boy, and Blackfeet Reservations, and the potential for significant increases in water use in the Canadian portion of the watershed.[129]

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[124] U.S. Department of the Interior, Bureau of Reclamation, Montana Area Office. 2004. *Regional Feasibility Report: North Central Montana*. October. Page 30.

[125] U.S. Department of the Interior, Bureau of Reclamation, Montana Area Office. 2004. *See* footnote 124. Page 29.

[126] Personal Communication with Paul Azevedo. State Coordinator for the Rehabilitation of the St. Mary Facilities, Department of Natural Resources and Conservation (DNRC). May 22, 2008.

[127] *See* for example, Azevedo P. 2004. *The Need to Rehabilitate the St. Mary Facilities*. Retrieved June 16, 2008, from http://dnrc.mt.gov/st_mary/pdfs/stmarybackground.pdf

[128] Azevedo P. 2004. *See* footnote 127.

[129] U.S. Department of the Interior, Bureau of Reclamation, Montana Area Office. 2004. *See* footnote 124.

These possible future changes in water supply exist in the context of a project that is already undersupplied by water and a basin in which virtually all water has already been appropriated and/or developed. The Milk is now closed to new water right permits, with the last new irrigation permit being issued in 1985.[130] In sum, it appears the challenge on the Milk is not how to expand irrigated acres, but how to better and more fully and reliably serve existing irrigated lands.

2. Water Use

As described above, Milk River Project water is largely used for irrigating hay and forage for livestock operations. Farmers have also planted other crops in recent years, including malting barley, organic grain crops, grass seeds and new varieties of corn and soybeans suited for the Milk's short growing season.[131]

Crops produced with irrigation are not the only products resulting from the Project's water, however. The wetlands at Bowdoin National Wildlife Refuge rely on Milk River project water,[132] and numerous wetlands occur up and down the Milk River as a result of waste water from project lands. The Project also supports fishing and water-based recreation at Fresno and Nelson reservoirs, fishing and fish habitat for threatened species in the Milk River itself. The cottonwood bottoms and irrigated fields created by the project have in turn led to pheasant and whitetail deer hunting that is nationally known for its quality.[133] Over 14,000 people in the basin rely on project water for municipal use. In addition, it is believed that many of the public and private groundwater wells located in the Milk River bottoms that do not acquire water directly from the project are augmented by the increased flows in the Milk resulting from the project, and by the leakage from the project's irrigation ditches.[134]

The legal and physical inability to obtain new water rights on the Milk has been either formally recognized or practically evident for a number of years. The first step towards formally closing the Milk to new appropriations came in 1985, when the legislature authorized DNRC to identify and close areas in the basin where it was deemed no water was available for appropriation. More recently, the Fort Belknap Compact has effectively closed the basin, from the point where the Milk re-enters Montana above Fresno to its confluence with the Missouri, to nearly all new appropriations of water.[135]

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[130] Personal Communication with Bob Larson, DNRC Regional Manager in Havre. June 11, 2008.

[131] Personal Communication with Randy Reed. *See* footnote 119.

[132] Personal Communication with Carmen Luna, Bowdoin National Wildlife Manager. June 10, 2008.

[133] Personal Communication with Larry Mires. *See* footnote 119.

[134] Personal Communication with Michael Daily. *See* footnote 114.

[135] Personal Communication with Bill Greiman, Montana Reserved Water Right Compact Commission Agricultural Engineer. May 27, 2008

As a result, existing water rights will of necessity become the "currency" needed for developing new water uses in the basin. However, the basin's existing rights have not yet been defined and quantified with enough accuracy that they can readily be moved from one party to another, or from one use to another.

Defining and quantifying existing water rights, at least the historic rights that pre-date July 1, 1973, is the focus of the Montana Water Court's massive statewide adjudication. There are over 30,000 claims filed for historic rights in the Milk and St. Mary drainages. As of 2008, nearly 6,700 Milk River basin claims had appeared in Preliminary Decrees, nearly 4,400 had appeared in Temporary Preliminary Decrees, and nearly 19,000 had been examined by DNRC. Claim examination is the last major stage of the adjudication process prior to issuance of a decree. Currently, the Water Court schedule calls for decrees to be issued in all Milk River sub-basins by 2011, with the 181 claims in the relatively small St. Mary basin appearing in a decree by 2012.[136]

Because of the rounds of objections, counter objections, negotiations and hearings that follow the issuance of a decree, it is quite likely that historic water rights in the Milk and St. Mary basins will not be completely adjudicated until 2020. In the interim, uncertainty about underlying rights will make efficient water management, and the reallocation and relocation of existing to more profitable uses and lands more difficult. Figure IV-6, below, shows the adjudication states of the Milk River.

Water right compacts with the Rocky Boy, Fort Belknap and Blackfeet tribes also have the potential to materially affect the Project area. The recently negotiated compact between Montana and Fort Belknap establishes the tribe's first right to 645 cfs of the natural flow of the Milk River, which is effectively the entire natural flow of the river. In effect, the compact is believed to make it possible for Fort Belknap to increase its use of Milk River water by about 10,000 acre feet. Similarly, the compact with the Rocky Boy (Chippewa Cree) could increase use in the basin by the tribes' senior rights by as much as 3000 acre feet. The compact proposed for the Blackfeet establishes a right for the tribe of 50,000 acre feet from the project's St. Mary diversion.[137] While it is not anticipated that the tribe will use this water for irrigation on its own land, it is likely the water will be marketed, and this may result in higher charges for project irrigators.

3. Institutional Structures and Management Issues

The institutional structures and number of players on the Milk are quire extensive. The Milk River Project is comprised of eight irrigation districts, within three divisions, strung out over 400 miles of the Milk River. In addition, the project provides water to about 200 individual contract water users, locally

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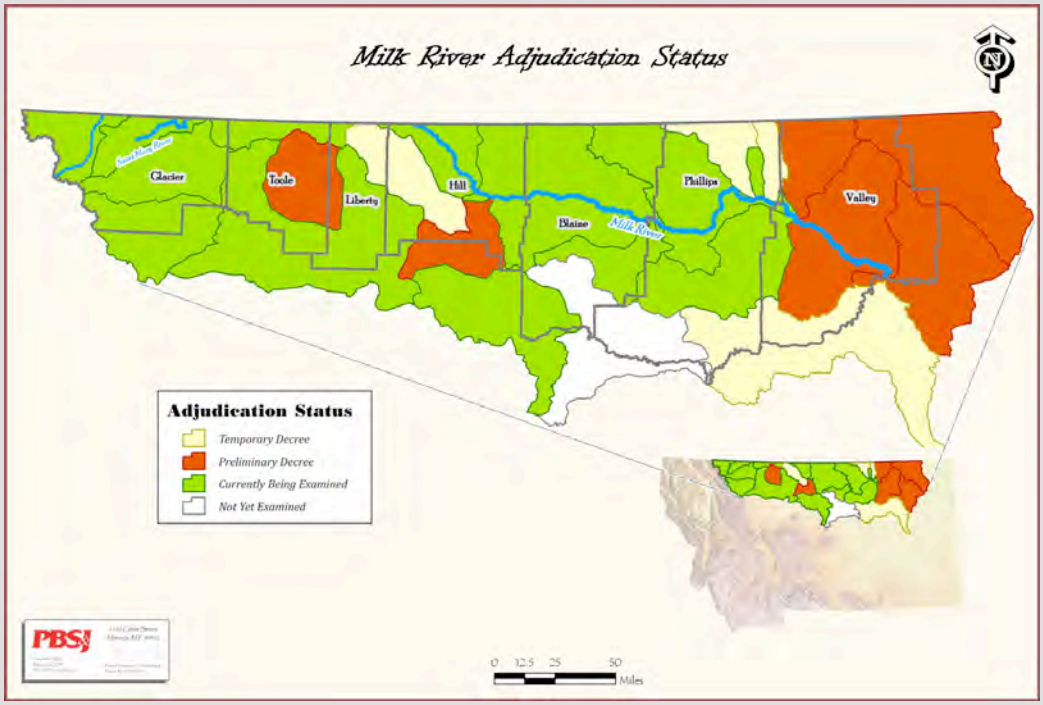
[136] Montana DNRC. 2004. *Water Adjudication Status Report*. Retrieved June 2, 2008, from http://dnrc.mt.gov/wrd/water_rts/adjudication/default.asp

[137] Personal Communication with Bill Greiman. *See* footnote 135.

Figure IV-6. Status of Water-Rights Adjudications in the Milk River Basin



Source: PBS&J

known as "pumpers."[138] Pumpers divert directly from the Milk, and do not directly rely on irrigation district infrastructure. The relative location of the water users of the Milk River Project, with diversions of widely varying size scattered along 400 miles of river, many located outside of the boundaries of a district, makes water management challenging. The location of users upstream and downstream from one another rather than on a common diversion makes competition for water between users, districts, and divisions nearly inevitable, and complicates the ability to deliver the right amounts of water at the right times.[139]

One of the advantages of the sequential use of Milk River water is that downstream users stand to use return flows from upstream irrigation. The increasing salinity of the Milk as it flows to the Missouri is likely a reflection of this re-use of water.[140] Effectively, this arrangement means the amount of water actually cumulatively applied to the land by irrigators is greater than the sum of the St. Mary diversion and the natural flow of the river. The reuse of return flows

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[138] Personal Communication with Lenny Duberstein. *See* footnote 118.

[139] Personal Communication with Michael Daily, *See* footnote 114.; Personal Communication with Randy Reed. *See* footnote 119; Personal Communication with Steve Page, Glasgow area rancher. June 2, 2008.

[140] Personal Communication with Michael Daily. *See* footnote 114.

may be one of the reasons that the volume of water used on average by Milk irrigators is typically more than 1.5 acre feet per acre,[141] a volume that is comparable to water usage on the Greenfields District.

However, reliance on return flows on many western streams has served as a disincentive to upstream users for efficient irrigation. Why use water efficiently if the excess water is not, ultimately, truly wasted but becomes available to downstream users? Return flows are more difficult to manage than stored water in terms of quantity and timing. Timing is a particularly challenging issue on the 400 river miles located in the study area. It requires 10 days for water released from Fresno to reach the Glasgow irrigation District. Under systems heavily reliant on return flows, water is often simply used by individual users in as great a quantity as possible whenever it is possible to irrigate, rather than when irrigation water is most badly needed.[142]

The timing problem is made more acute on the Milk because the project is dominated by one type of crop, in this case, forage crops. Since so many water users are irrigating the same "crop", water needs are not distributed evenly across the irrigation season but rather are felt most keenly at approximately the same times along the entire length of the project. This creates a bottleneck on the demand, and makes delivering water in a timely manner along the whole length of the project more difficult.[143]

In addition, water costs for individual users are based on number of irrigated acres, not on actual volume of water used. As a result, there is no added cost for using water inefficiently. While basing water charges on irrigated acres is a common practice for Montana irrigation projects, this practice can serve as a disincentive to use water efficiently when water use is not systematically regulated or monitored.[144]

There has been local discussion regarding whether existing water management practices and coordination between various water users or user groups is sufficient to effectively manage the project's limited water supply. Those discussions have accelerated in recent years in view of the fact that to the extent management insufficiencies exist, they will be made more acute by further deterioration of water supply or failure of the St. Mary diversion. In 1999 the irrigation districts formed a Joint Board of Control (Board) to improve coordination and communication between the districts. Although the Board does not have authority over internal management of any of the irrigation districts, it

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[141] Personal Communication with Jennifer Brandon. *See* footnote 123.

[142] Personal Communication with Steve Page, Glasgow area rancher. June 2, 2008.; Personal Communication with Lenny Duberstein. *See* footnote 118.

[143] U.S. Department of the Interior, Bureau of Reclamation, Montana Area Office. 2004. *Regional Feasibility Report: North Central Montana.* October.

[144] Personal Communication with Michael Daily. *See* footnote 114.

has provided a forum where the historically competing units of the project can routinely communicate. One of the Board's initiatives has been to install measuring devices on the districts' on-stream diversions. In the past, there was suspicion and speculation about how much water each district was diverting. The measuring devices have helped address those concerns.[145]

The unique and challenging management issues that the Joint Board and its member districts are grappling with are perhaps most readily described by comparison to the Greenfields Irrigation District, discussed in Case Study 1. Greenfields effectively has one governing body for its 80,000 acres. Malta has eight districts, three divisions, and one Joint Board of Control for an irrigated acreage only slightly larger than Greenfields. In addition, there are 200 contract pumpers, 350 claims to historic water rights, and 21 post-1973 water right permits located on the mainstem of the Milk that can currently divert with little or no regulation.[146]

Because all Greenfield's lands lie within a single district, its ability to fund maintenance and rehab projects comes from a common pool. As described in the first case study, Greenfields has been very proactive and currently has no major deferred maintenance issues. This is believed to be due in part to the consensus and shared self interests that exist on Greenfields. The ability to raise funds on the Milk is based on relatively smaller individual districts, limiting the ability of those districts to undertake larger rehabilitation projects, and removing incentive to assist with the infrastructure needs of the other districts.

An example is the Vandalia Dam, which serves as the diversion for the Glasgow Irrigation District. The 18,000 irrigated acres serving as the assessment base of the Glasgow District provide limited funds for the badly needed rehab work required at Vandalia. Pooling costs for this rehab across all 8 districts to address this deferred maintenance is seen by many in those other districts as inequitable.[147] However, over the long term, the districts might be better served by improving their collective ability to raise the funds needed to address major infrastructure costs, even those periodic costs that are only linked with a specific district.

There has been some movement recently towards formally pooling costs across larger user groups. Malta Irrigation District now includes the 40 contract pumpers that are located along its reach of the Milk within its tax base.[148]

It is widely agreed that water on the Milk project is less-precisely administered than on the Greenfields. Although a number of measuring devices have been

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[145] Personal Communication with Jennifer Brandon. *See* footnote 123.

[146] Personal Communication with Lenny Duberstein. *See* footnote 118.

[147] Personal Communication with Michael Daily. *See* footnote 114.

[148] Personal Communication with Jennifer Brandon. *See* footnote 123.

installed in recent years, coordination between districts is still limited. Water use by pumpers continues to be largely unregulated and measured inconsistently. Although water is now measured at most headgates, water distribution down-ditch is often not.[149]

In sum, a comparison with the Greenfields Case Study demonstrates that in the Milk River Project, there are fewer individual incentives to use water efficiently, many incentives for a water user to act unilaterally, and a lack of infrastructure in place to administer water more effectively.

D. Proposed or Recent Investments

The St. Mary diversion is just one of many parts of the Milk River Project that have been identified as in need desperate need of rehabilitation.[150] Funding has been the major obstacle to initiating work on these projects. Current estimates to rehabilitate the St. Mary diversion alone range between $75 and $125 million. In 2007, Congress authorized funds of $153 million for the project.[151] However, funds for many of the other projects have yet to be identified.

Currently, Milk River irrigators comprise the only Montana interest group formally tasked with paying for the work needed to rehabilitate the St. Mary system. Given the widespread benefits of the project, it is widely asserted that mechanisms need to be established to share the rehabilitation costs more broadly as well.[152]

One of the concepts being explored that would facilitate looking at Milk River in a basin wide, inclusive context is a "Milk River Authority". The exploration of a Milk River Authority" entails identification of all the project's many beneficiaries, both inside the basin and out. A Milk River Authority would bring together those stakeholders for purposes of giving each a voice in water management, and to provide a more equitable means of funding water related initiatives. Current law regarding water conservancy districts in Montana is not believed to be adequate to achieve the widespread sharing of costs that are envisioned for the problems faced by the Milk. River Basin Authorities in other states are being examined to find a model that fits the Milk.[153]

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[149] Personal Communication with Bob Larson. *See* footnote 130.

[150] *See,* for example, Azevedo, P. No Date. *The Need to Rehabilitate the St. Mary Facilities.* Montana Department of Natural Resources and Conservation. Retrieved June 9, 2008, from http://dnrc.mt.gov/st_mary/pdfs/stmarybackground.pdf

[151] Azevedo, P. 2007. "St. Mary Rehabilitation Project Advances on Several Fronts." *Milk River Watershed News.* Fall. Retrieved February 20, 2008, from http://dnrc.mt.gov/st_mary/news/2007/fall.pdf

[152] Personal Communication with Larry Mires. *See* footnote 119.

[153] Personal Communication with Larry Mires. *See* footnote 119.

E. Goods and Services Affected by Irrigation

The economic costs and benefits of irrigation infrastructure have been explored at length in the Milk River Project area over the last few years. The Bureau of Reclamation and other economists have conducted several analyses in association with various plans to rehabilitate the Project's infrastructure and repair the St. Mary diversion to ensure that the St. Mary River's flows continue to augment those of the Milk River, which are by themselves insufficient to sustain irrigation and other uses at current rates within the Project area. Although the Milk River Project irrigation infrastructure currently provides a wide range of goods and services that shape the quality of life in the Milk River area, this is not to say that the Milk River would not provide goods and services absent irrigation. The Milk River provided valuable goods and services before the Bureau and private irrigators constructed the area's irrigation infrastructure, and would still today, had the irrigation infrastructure not been developed. Undoubtedly, the set of goods and services provided without irrigation would look markedly different than with irrigation. It is unlikely that without irrigation and its associated infrastructure, the goods and services provided by the Milk River would support the region's communities, agricultural economy, and way of life as they look today.

The irrigators of the Milk River Project are currently engaged in negotiations to obtain federal funds to rehabilitate the St. Mary diversion. Without this rehabilitation, engineers and water managers predict that the structures would fail and water would no longer flow from the St. Mary River into the Milk River, reducing annual flows by up to 90 percent. As part of these ongoing funding negotiations, the Bureau of Reclamation and private economists have conducted analyses of the costs and benefits of rehabilitating the Milk River Project. The most extensive and complete analysis was completed by the economic consulting firm Bioeconomics in 2006.[154] It evaluated the economic importance of Milk River Project flows to the Milk River area, and by extension, the state of Montana. This analysis suggested that the net economic benefits of Milk River Project flows are between $24 and $39 million annually.

1. Primary Goods and Services

In theory, the application of irrigation water to crops produces economic benefits in two ways: by increasing the yield of a crop that was previously cultivated without irrigation, or by enabling a farmer to grow a higher-valued crop. The benefit provided by irrigation shows up in the net farm income a farmer is able to earn from the crop, which is also translated into the value of irrigated land.

Net Farm Income. The U.S. Bureau of Reclamation completed a farm budget analyses for the Milk River Project lands in 2003. This analysis, which is based on assumed costs and production choices for a Milk River farm and helps the BOR

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[154] Bioeconomics. 2006. *St. Mary Diversion & Milk River Project Preliminary Economic Analysis: Impacts and Benefit-Cost Analysis.* Phase II, Task 4 – Economic Analysis. Final Report. August 30.

determine the ability of irrigators to pay for infrastructure improvements, shows that net farm income would be negative for both irrigated and non-irrigated operations. Irrigation provides an additional benefit of about $40 per acre per year, but it does not allow farmers to generate positive net incomes.[155] This picture is consistent with the actual net farm income received by farmers in many parts of the region since 2000. In Phillips and Blaine Counties, the net farm income between 2000 and 2006 was negative or nearly zero more often than not. Production expenses exceeded cash receipts from crops and livestock in six of the last seven years in every county in the region. Without government payments and other sources of income, collectively, farmers across the region would have reported losses in each of these years.[156]

Land Values. The U.S. Bureau of Reclamation estimated in 2003 that the value of irrigated land was $280 per acre higher than non-irrigated land: it estimated the value of irrigated land in the Milk River Project area at $610 per acre, and the value of non-irrigated cropland at $330 per acre.[157] Property values for irrigated lands are comparatively lower along the Milk River than other agricultural areas in eastern Montana because of poorer or less consistent soil quality, and to a lesser extent, due to the known problems associated with water delivery reliability within the Milk River Project.[158]

In 2005, an economic analysis of potential upgrades to the Milk River system reported that, based on interviews with real estate professionals in the region, irrigated land in the Milk River Project area without any advertised river frontage, recreational features, or other exceptional natural amenities, was priced on average about $280 per acre more than non-irrigated land, a difference in value similar to the Bureau of Reclamation's findings several years earlier. However, irrigated land with advertised amenities, such as wildlife habitat, river frontage, or other recreational opportunities, was priced considerably higher, around $500 to $1,500 higher per acre than non-irrigated land.[159] This suggests that, as many real estate appraisers familiar with property in the region have observed, amenity buyers who have put upward pressure on property values in many other parts of Montana are beginning to look to eastern Montana to purchase properties for hunting or recreational purposes.[160] Similar findings are

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[155] Otstot, R.S. 2003. *Milk River Benefits Analysis.* U.S. Department of the Interior, Bureau of Reclamation, Great Plains Region. April.

[156] U.S. Department of Commerce, Bureau of Economic Analysis. 2008. *Regional Economic Information System.* Retrieved June 9, 2008, from http://www.bea.gov/regional/reis

[157] Otstot, R.S. 2003. *See* footnote 155.

[158] Personal communication with Phyllis Sethre. Appraiser, Wolf Point. May 29, 2008.

[159] Bioeconomics. 2006. *St. Mary Diversion & Milk River Project Preliminary Economic Analysis: Impacts and Benefit-Cost Analysis.* Phase II, Task 4 – Economic Analysis. Final Report. August 30.

[160] Personal communication with George Luther and Phyllis Sethre, Appraisers in eastern Montana. May 29, 2008.

highlighted in the *Annual Montana Land Study*, produced by a real estate appraisal firm in Missoula, Montana. The 2006 report found that prices for agricultural land in eastern Montana are increasing rapidly, especially among properties advertised for their recreational values. According to the report, it is not uncommon to find properties along the Milk River that are offered for as much as $2,000 to $3,000 per acre, and are being purchased primarily for bird hunting and recreation.[161]

2. Complementary Goods and Services

Irrigation water diverted from the St. Mary basin provides flows for irrigation, and in doing so, provides water to support communities and lifestyles that would otherwise not exist in the basin. Above all, complementarity among water uses is the dominant theme in the Milk River basin—many different users benefit from the water that is imported into the basin for irrigation. The irrigation infrastructure supplies municipal and industrial water to local communities, provides recreation opportunities in area reservoirs, streams, and wetlands, and sustains fish and wildlife, including several threatened, endangered, and sensitive species.

The economic studies already completed in the Milk River region have identified and addressed the complementary goods and services provided by the Milk River Project. Table IV-2 provides a summary of the estimated benefits documented in these reports. While the study completed by Bioeconomics quantified the value of many of these goods and services, the study by the Bureau of Reclamation merely identified whether the benefit was positive or slightly positive. We describe each category of benefits in more detail below the table.

Table IV-2. Estimated Benefits Associated with Complementary Goods and Services Provided by the Milk River Project.

Benefit Category	Estimated Annual Benefits	
	Bioeconomics Study[a]	Reclamation Study[b]
Recreation	$2.3 to $3.8 million	Positive
Municipal Water Supply	$3.3 to $5.35 million	Positive
Water Quality	Not estimated	Slightly Positive
Ecosystem Services	Not estimated	Positive
Wetlands	$4.7 to $6.9 million	Not estimated

Source: ECONorthwest, adapted from Bioeconomics. 2006. *St. Mary Diversion & Milk River Project Preliminary Economic Analysis: Impacts and Benefit-Cost Analysis.* Phase II, Task 4 – Economic Analysis. Final Report. August 30.

[161] Norman C. Wheeler & Associates. 2006. *For Lands Sake: Annual Montana Land Study.* Retrieved April 30, 2008, from http://www.ncwheeler.com/newsletters/2006_for_lands_sakes.pdf

Municipal Water Supply. At least five towns and water districts directly rely on the Milk River Project for their municipal and industrial water supplies, and additional residents rely on the Project's associated aquifers. The Montana DEQ estimates that at least 18,600 people in the four-county region are served by these systems, and would have to secure alternative sources of water, but for the continued operation of the Milk River Project.

Recreational Opportunities. Fishing and non-angling recreation are both supported by the Milk River Project's reservoirs and river flows. In 2005, Montana Fish, Wildlife, and Parks (MFWP) estimated that in the stretch of the Milk River that falls within the study area, anglers fished over 27,000 days, which is just under the average number of angler days reported since 1999.[162] In an average year, the U.S. Bureau of Reclamation's Nelson Reservoir hosts almost 24,000 visitor days, and Fresno Reservoir hosts over 64,000 visitor days. People who use these reservoirs fish, swim, boat, picnic, camp, and watch wildlife, among other activities. Nelson Reservoir is particularly well-known for its northern pike fishery. Bowdoin National Wildlife Refuge, which is sustained by irrigation water, attracts nearly 2,000 people each year, who come to photograph wildlife and hunt.[163]

Fish and Wildlife Habitat, including Wetlands. The Milk River contains 5 of 18 Montana species of concern including the pallid sturgeon, paddlefish, blue sucker, pearl dace, and sauger. Research suggests that irrigation flows in the Milk River contribute to continued survival of these species in this region. Of particular importance, the Milk River provides some of the most important spawning and rearing habitat for species found in the Missouri River.[164] In its 2006 report, Bioeconomics suggested that the continued survival of Montana's threatened and endangered warm water fisheries could be the largest category of benefits from Milk River Project water, but estimation of this category is difficult, and was not included in the final calculation of benefits shown in Table IV-2.

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[162]McFarland, R.C. and J. Dykstra. 2007. *Montana Statewide Angling Pressure Mail Survey 2005.* Montana Fish, Wildlife, and Parks. July. Retrieved April 30, 2008, from http://fwp.mt.gov/content/getItem.aspx?id=29639; Montana Fish, Wildlife, and Parks. 2008. *Montana Fishing Guide: Milk River.* Retrieved April 30, 2008, from http://fwp.mt.gov/fishing/guide/q_Milk_River__1063176480558_0_497.6.aspx; and Montana Fish, Wildlife, and Parks. 2008. *Montana Fishing Guide: Nelson Reservoir.* Retrieved April 30, 2008, from http://fwp.mt.gov/fishing/guide/q_Nelson_Reservoir__1075485484911_0_1.aspx

[163] U.S. Department of the Interior, Bureau of Reclamation, Montana Area Office. 2004. *Regional Feasibility Report: North Central Montana.* October.

[164] National Research Council, Committee on Missouri River Ecosystem Science. 2002. The Missouri River Ecosystem: Exploring the Prospects for Recovery. Washington D.C.: National Academies Press; Stash, S., R.G. White, and D. Fuller. 2001. *Distribution, Relative Abundance, and Habitat Associations of Milk River Fishes Related to Irrigation Diversion Dams*. USGS Cooperative Fishery Research Unit, Montana State University, Bozeman, Montana; Montana Fish, Wildlife, and Parks. 2008. Montana Fishing Guide: Milk River. Retrieved June 9, 2008, from http://fwp.mt.gov/fishing/guide/q_Milk_River__1063176480558_0_650.630004882813.aspx

The Milk River flows and irrigation return flows contribute to sustaining wetlands throughout the basin, which would not be as extensive if irrigation were to cease. Wetlands provide important habitat for the region's birds and other wildlife, and provide important ecosystem services, such as water filtration and infiltration, which recharges underlying aquifers. In particular, irrigation return flows sustain the wetlands of the Bowdoin National Wildlife Refuge, which provides habitat for over 250 bird species and other wildlife.[165]

3. Competing Goods and Services

During the irrigation season, from May through September, flows imported from the St. Mary River support up to 70 percent of the Milk discharge at Havre in average years, and up to 90 percent of project water in dry years.[166] Diverting this water from the St. Mary Basin to the Milk River Basin results in some goods and services foregone in the St. Mary River Basin. For example, the Bureau of Reclamation suggests that without diversions to the Milk River, fisheries in the St. Mary River would improve with the removal of the diversion dam and return to more natural flows in the river. In particular, the bull trout, a threatened species found in the St. Mary River, would probably be better off.[167] A comprehensive analysis of the costs that accrue in the St. Mary Basin from diverting water to the Milk River Basin has not, to our knowledge, been conducted.

4. Trends and Factors Influencing Goods and Services

Water rights adjudications and compacts, climate change, and regular fluctuations in prices of production inputs and commodity prices all have the potential to affect the level of goods and services provided by the Milk River Project.

The legal and physical inability to obtain new water rights in the Milk has been either formally recognized or practically evident for a number of years. As in most basins that are closed to new appropriations of water across Montana, existing water rights in the Milk will over time gain significance and value. Before existing rights can be readily moved around within the project area to their best and highest uses, appropriate procedures for doing so will need to be developed. Just as critically, the existing rights will have to be precisely defined and quantified. Precisely defined and quantified water rights are more easily managed and reallocated to more valuable uses. Because of the rounds of

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[165] Montana Fish, Wildlife, and Parks. 2008. *Montana Fishing Guide: Milk River*. Retrieved June 9, 2008, from http://fwp.mt.gov/fishing/guide/q_Milk_River__1063176480558_0_650.630004882813.aspx

[166] Personal Communication with Paul Azevedo. State Coordinator for the Rehabilitation of the St. Mary Facilities Department of Natural Resources and Conservation (DNRC). May 22, 2008

[167] U.S. Department of the Interior, Bureau of Reclamation, Montana Area Office. 2004. *Regional Feasibility Report: North Central Montana.* October.

objections, counter objections, negotiations and hearings that follow the issuance of a decree, it is quite likely that historic water rights in the Milk and St. Mary basins will not be completely adjudicated until 2020. In the interim, uncertainty about underlying rights, will make efficient water management, and the reallocation and relocation of existing to more profitable uses and lands more difficult.

Scarce availability of new water rights will undoubtedly increase competition for existing water supplies from the Milk River Project. Climate change will likely exacerbate this scarcity. Climate change is expected to impact water supplies that originate from the snowpack of the Rocky Mountains, by reducing the overall amount of precipitation, and increasing the amount of precipitation that falls as rain instead of snow during the year, resulting in less spring runoff. Although the natural flows of the Milk River do not originate from snowpack in the Rocky Mountains, the majority of the annual flows in the Milk River Project, diverted from the St. Mary River, do. To the extent that climate change affects these flows, farmers, ranchers, and other users of the Milk River Project will likely encounter droughts of increased frequency and duration, and greater variability in flooding events throughout the year. This latter impact will likely add extra wear and tear to already-compromised infrastructure.

Amidst these challenges to water supplies in the Milk River, irrigators will continue to face rising and falling commodity prices. This, in itself, is not a new factor on the agricultural landscape. However, the rising prices of oil, as well as other inputs to production, such as fertilizer, compound uncertainty and make investments in new infrastructure more risky. This is especially true in a region that is distant from the region's major agricultural markets, which can make entry into new markets difficult. Transportation costs were a major factor in why the beet industry in the area eventually failed, and may offer caution to other farmers looking to expand beyond the traditional alfalfa and forage crops grown across much of the region.

F. Summary, and Expectations for Future Investments

New investments in the Milk River Project, related to the rehabilitation of the St. Mary diversion and canal, appear poised to move forward, although hurdles must yet be overcome before they will materialize. This case study offers a variety of insights into how such an investment may affect the level of goods and services produced by irrigation in this region.

No other irrigated area in Montana is more dependent on the importation of water from another basin. For this reason, here more than in other places in Montana, infrastructure associated with irrigation provides many complementary goods and services that the region's residents and visitors enjoy and depend upon. These include municipal, residential, and industrial water; a wide offering of water-based recreation, fishing, and hunting opportunities; and fish and wildlife habitat for threatened and endangered species. Without the additional water flowing into the basin by way of the St. Mary diversion and canal—which was constructed to provide irrigation water to the Milk River

basin—these other goods and services would not likely exist in the basin at levels that they do today. Diverting the water from the St. Mary basin does not come without tradeoffs, however, most notably, potential impacts to the threatened bull trout found in the St. Mary River.

While it is clear that future investments to ensure the Milk River Project waters continue to flow would sustain a wide variety of goods and services external to irrigation, it is less clear how sustaining irrigation flows would affect the level of goods and services produced directly through irrigation. Both irrigated and non-irrigated agriculture struggle in this region, as historical data on net farm incomes indicate. There are some inherent qualities of the landscape that combine to make irrigated agriculture more of a struggle in this region than most other regions in Montana, regardless of levels of investment. For example:

- Soils in the Milk River Valley are more varied, with some lands well drained and readily farmed, while others comprised of more tightly packed clays that do not readily drain and are not as suitable for irrigated farming.

- The sinuous character of the Milk River makes efficient application of water difficult. The Milk River winds through a mostly narrow bottomland for 400 miles to cover a straight-line distance of 160 miles from Havre to the rivers mouth on the Missouri. The result is that, other than in the relatively broad river bottom characteristic of the Chinook area, most fields lie within or on the outside of the arc of the river's meandering channel. The resulting fields are small, irregularly shaped, or both. Sprinkler systems are often not a feasible option. For example, one rancher near Glasgow has 1,200 acres of irrigated land, but, because of river meanders, those acres are divided into 62 distinct irrigated fields. While not always this extreme, this type of field pattern is common, and likely one of the reasons that flood irrigation remains prevalent on the Milk, with 79 percent of the land being irrigated using flood systems and 21 percent using sprinklers. This, in turn, can be an obstacle to more efficient water use.

- Some of the more potentially productive land in the Milk River region are found on benchlands located just outside of historic project/district boundaries. As we discuss in the Lower Missouri and Lower Yellowstone Case Study, these types of bench are the setting for much of the increase in irrigation from the lower Yellowstone and the Lower Missouri in recent years. Although there are similar lands in the Milk River Valley, lands that might be more productive than some of existing irrigated lands lying within the project, legally relocating project water to these lands is very difficult. Both Montana water law regarding changes in place of use, and Bureau of Reclamation policies make relocating existing water use other sites difficult.

- The distance from the Milk River region to major interstate highways and economic centers diminishes farmers' ability to compete with other

farmers closer to such areas. This is especially true in a world where rapidly rising transportation costs can have a significant influence on the marketability of a particular product.

These factors aside, based on our interviews with people directly involved with agricultural production in the Milk River Valley suggest that investments in improving the efficiency and reliability of the entire system may produce some positive economic outcomes.

Improvements in infrastructure reliability and water management practices may allow farmers to make long-term investments, including diversifying their crops to include those that depend upon precise and reliable application of water. Currently, management issues within the Milk River Project, including uncertainties about future water supplies and the reliability of the water infrastructure, combine to discourage pursuit of alternatives to forage crops, which may prove more profitable for farmers. Commitment to non-forage crops cannot readily be made annually. Seed potatoes, sugar beets, malting barley—all crops grown with success in other irrigated regions in Montana—require that farmers make a longer-term commitment. This is difficult when there is a non-trivial probability that the water supply may be significantly reduced due to infrastructure failures. Further, even though many of these crops require less water than forage crops, the certainty that water will be delivered to these crops in adequate amounts and, most important at critical times is difficult to assure under current water-management practices, or the lack thereof. In other parts of Montana, such as the Greenfields Irrigation District and the Lower Yellowstone River, the benefits of a reliable irrigation system reflect directly on property values, because it increases the potential of what a farmer might be able to do with the land. It is unclear the extent to which increased reliability would affect property values in the Milk River Project, especially given the other issues raised above, but evidence from elsewhere suggests it would have a positive effect.

In summary, irrigation in the Milk River Valley faces challenges in terms of infrastructure reliability, water management, and geography that have, to this point, made irrigated agriculture more challenging than in other regions in the state. Factors, such as climate change, water rights adjudications and water compacts, and increasing costs of production may put further stress on an already tenuous situation. The failure of an irrigation project would, in most parts of the west, have a serious impact on the local economy. However, in most western basins, rivers would continue to flow, water would still be available for municipal, industrial uses, and fish and wildlife habitat might in some cases be enhanced. Reservoirs might still be available for recreation.

The Milk River does not conform to this model. Arguably, because the Milk River Project entails the importation of a large volume of water into what was historically a modestly-sized river, the failure of the project would compromise more than irrigation and the irrigation-related economy. Reservoirs such as Fresno and Nelson would lose most of their recreation value. The waterfowl habitat at Bowdoin refuge and numerous de-facto wetlands would be compromised. The amenity values, such as deer and bird hunting, that are

raising land values in the area would be reduced. Community water supplies would be impacted. Habitat for several fish species of concern would be impacted. Impacts of a water shortage would not be limited to users located immediately on the Milk. Milk River water users would likely "make call' on upstream junior water right holders on tributary streams in attempts make up for the shortfall. Put differently, in some cases, a failed irrigation project would mean more water available for competing local interests. In the case of the Milk River Project, failure of the project would mean less water for many interests.

V. Case Study 4: Irrigation in the Lower Yellowstone and Lower Missouri River Valleys

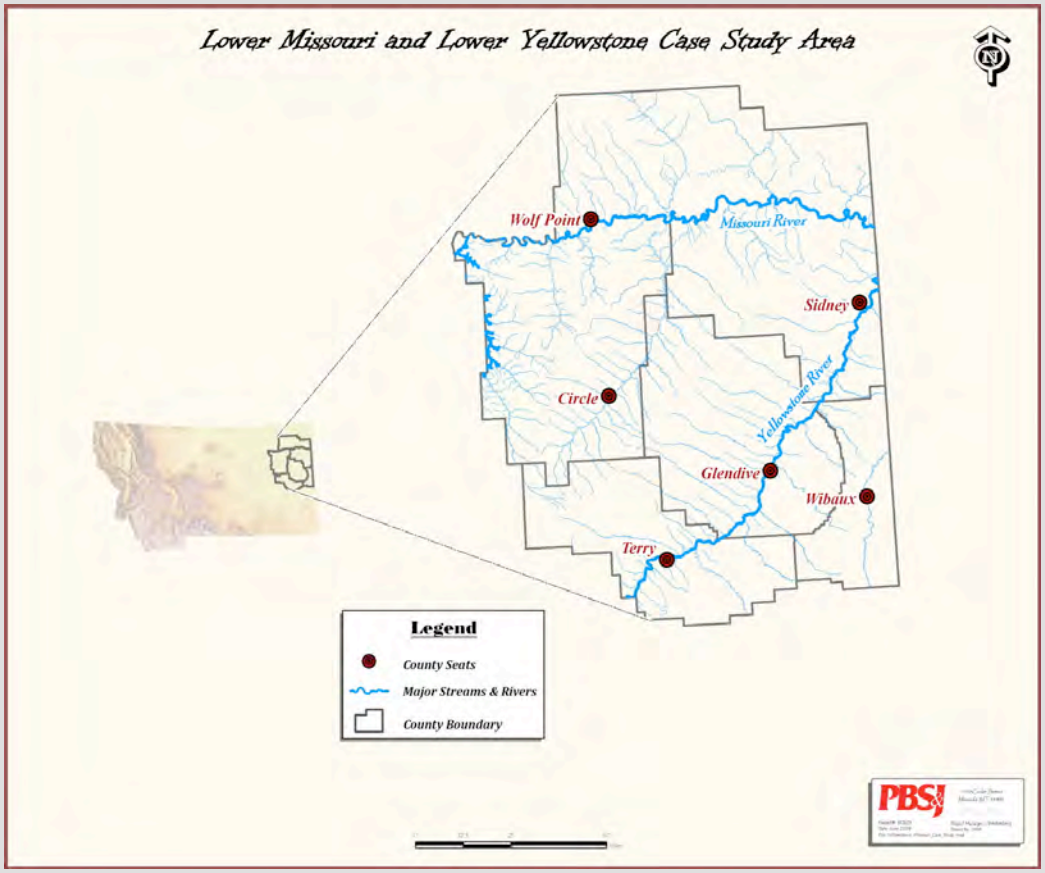
A. Description of the Study Area

1. Study Area Boundaries

We focus this case study on irrigated agriculture along the lower Missouri River Valley downstream of Fort Peck Reservoir, and the lower Yellowstone River Valley downstream of its confluence with the Powder River. This stretch of the lower Missouri River flows through Valley, McCone, Roosevelt, and Richland Counties. This stretch of the lower Yellowstone River flows through Richland, Dawson, and Prairie Counties. These groupings of counties form our case study boundaries, shown in Figure V-1.

The lower Missouri River Valley case study region includes the Fort Peck Indian Reservation and the major populated areas of Wolf Point, Poplar, and Culbertson. The lower Yellowstone case study region includes the towns of Sidney, Glendive, and Terry.

Figure V-1. Map of the Case Study Area



Source: PBS&J

2. Description of the Region's Population and Economy

Montana's Missouri River valley below Fort Peck and the lower Yellowstone River Valley below the Powder River comprise the epicenter of agriculture in the eastern third of Montana. And while other sectors of the economy, such as oil and gas development are important contributors to local economies, agriculture, as a percentage of economic activity, remains important in this part of the state.

The U.S. Bureau of Economic Analysis associates the counties in this case study with the economic center of Billings, over 200 miles to the west.[168] The counties are connected to Billings by a major interstate highway, but distance isolates these counties from much of the economic activity generated within the Billings metropolitan area. The largest city within the three-county area is Sidney, in Richland County with Glendive, in Dawson County a close second. The next-largest nearby population center is Williston, across the border in North Dakota, where many people in the region go for shopping, entertainment, and medical services.

The arid high-plains country of the Western united States, including the areas through which the lower Yellowstone and Missouri rivers flow, is frequently described in national publications as dying: populations are declining, and communities are withering away.[169] Climatically, the study area conforms to the high plains stereotype. The counties in the study area receive relatively little moisture—around 14 inches of precipitation each year.[170]

However, the study area does not completely conform to the national stereotype of the high plains, largely due to the existence of the irrigated agriculture the Lower Yellowstone and lower Missouri Rivers make possible. The river corridors contain some of Montana's most productive agricultural lands, and also contain the highest population densities in eastern Montana. Although the area is arid, and unlike western and central Montana, does not benefit from local sources of high elevation snow pack to augment tributary streams, the rivers themselves have substantial flows, much of which remains available for appropriation.

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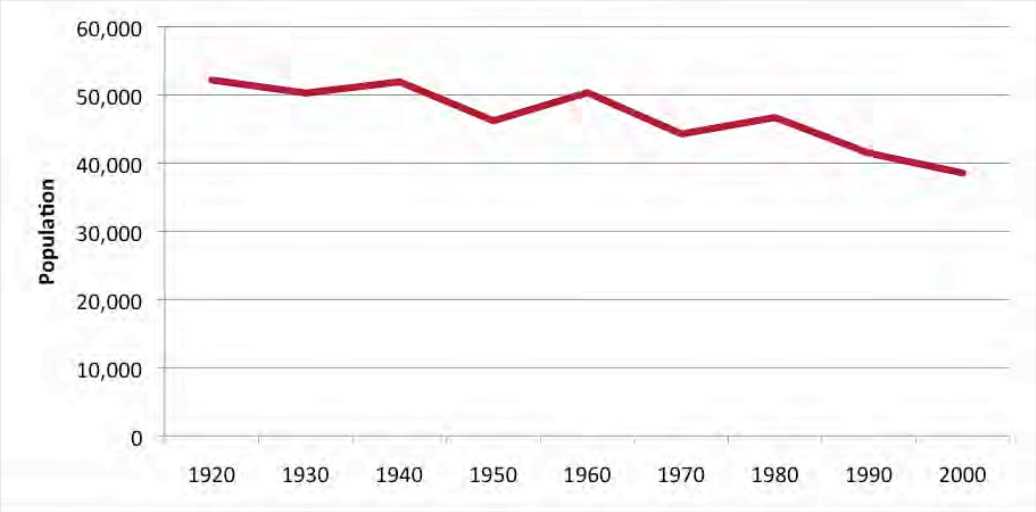
[168] The U.S. Bureau of Economic Analysis delineates regional markets throughout the country, which it calls Economic Areas. The Areas consist of economic nodes that are centers of regional commerce, and the surrounding counties that are economically related to the nodes. Montana is divided into four Economic Areas: Great Falls, Billings, Helena, and Missoula. The areas are redrawn periodically based on commuting data from the decennial census, on statistical areas from the Office of Management and Budget, and on newspaper circulation data from the Audit Bureau of Circulations. The Bureau of Economic Analysis last redrew the boundaries in 2004.

[169] *See* for example, Egan, T. 2003. "Vanishing Point; Amid Dying Towns of Rural Plains, One Makes a Stand." *New York Times.* December 1. Retrieved May 14, 2008, from http://query.nytimes.com/gst/fullpage.html?res=9D04E4D8103AF932A35751C1A9659C8B63

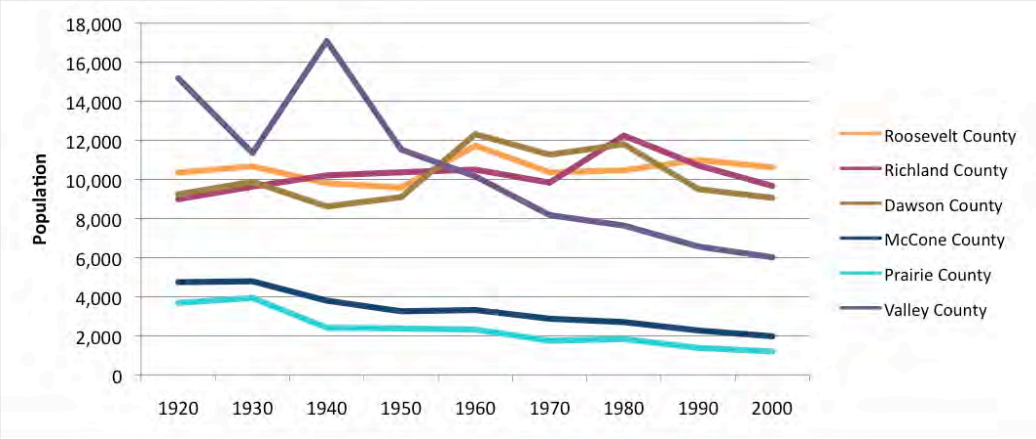
[170] Miller, J.F., Frederick, R.H., Tracey, R.J. 1973. *Precipitation-Frequency Atlas of the Western United States*, Washington, D.C.: U.S. Department of Commerce. Pg. 31; and U.S. Department of the Interior, Bureau of Reclamation. 2008. *Agrimet: Great Plains Region*. Retrieved April 30, 2008, from http://www.usbr.gov/gp/agrimet/agrimet_station_list.cfm

Figure V-2. Regional Population Trend between 1920 and 2000



Source: ECONorthwest, with data from Forstall, R.L. 1995. *Population of Counties by Decennial Census: 1900 to 1990.* U.S. Department of Commerce, Bureau of the Census, Population Division. Retrieved May 14, 2008, from http://www.census.gov/population/cencounts/mt190090.txt

Figure V-3. Population Trend for Each County between 1920 and 2000



Source: ECONorthwest, with data from Forstall, R.L. 1995. *Population of Counties by Decennial Census: 1900 to 1990.* U.S. Department of Commerce, Bureau of the Census. March 27. Retrieved June 5, 2008, from http://www.census.gov/population/cencounts/mt190090.txt

Securing water rights and increasing irrigated acres has both encouraged, and been a response to, demand by local processers for malting barley and sugar beets. The byproducts of agricultural processing plants has in turn been a factor the establishment of several dairies in the area over the past decade. The synergy of high value crops and their associated infrastructure have the promise to make significant contributions to the local economy. These high value crops all depend on irrigation.

Notwithstanding the irrigated river corridors, the region's population has declined since it reached its peak soon after the close of the homesteading boom around 1920, although not precipitously, as Figure V-2 shows. The region's population was 32,158 in 2006, approximately 80 percent of what it was at its peak.

The trends that lead commentators to describe the high plains as "dying" are particularly strong in two of the case study counties: Prairie and McCone. In these counties, the population today is less than a third of what it was in 1920, as Figure V-3 shows. The population of these counties is also older than the others—the median age ranges from 42 to 48.5 (see Table V-1, below), compared with a state median of 37.5. In contrast, Roosevelt, Richland, and Dawson Counties never experienced a precipitous decline in population, although it has fluctuated over the decades, and the median age of the county's populations remain closer to the state average. In fact, the population in Roosevelt County has held steady in recent years, probably owing to recent population growth on the Fort Peck Reservation.[171]

Per capita personal income in 2006 for most of the counties in the region was lower than the state as a whole, and a larger percentage of the population lies below the poverty level in all but Richland County (see Table V-1).[172] The unemployment rate for the counties in the region has fluctuated over the last two decades, but in recent years has leveled off, and remains at or below the annual average for Montana in all but Roosevelt County, as Figure V-4 shows. The unemployment rate in Roosevelt County is influenced by high unemployment rates reported on the Fort Peck Indian Reservation. Officially, the U.S. Census Bureau estimated in 2000 that the unemployment rate on the Reservation was 10.9 percent, and the Montana Department of Labor and Industry estimated a rate of 9.9 percent in 2006.[173] However, the U.S. Bureau of Indian Affairs estimated an unemployment rate of 54 percent in 2005 among enrolled members of the tribes that live on the Reservation.[174]

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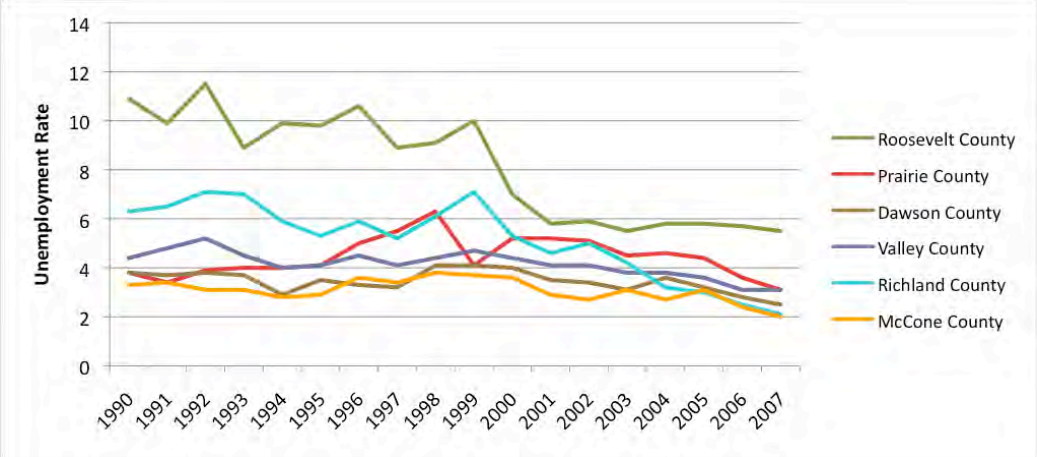
[171] Montana Department of Commerce, Census and Economic Information Center, Montana Department of Labor and Industry, Research and Analysis Bureau, and the Governor's Office of Indian Affairs, State Tribal Economic Development Commission. No Date. *Demographic and Economic Information for Fort Peck Reservation.* Retrieved May 7, 2008, from http://www.ourfactsyourfuture.org/admin/uploadedPublications/1745_Ft_Peck_RF06_Web.pdf

[172] U.S. Department of Commerce, Census Bureau. 2008. *American FactFinder, Factsheets* [for Roosevelt, Richland, Dawson, McCone, Prairie, and Valley Counties.] Retrieved May 14, 2008, from http://factfinder.census.gov/home/saff/main.html?_lang=en

[173] Montana Department of Labor and Industry, Research and Analysis Bureau. 2008. *Montana Reservation Labor Force Statistics: 2006 Annual.* Retrieved May 14, 2008, from http://www.ourfactsyourfuture.org/?PAGEID=67&SUBID=220

[174] U.S. Department of the Interior, Bureau of Indian Affairs. 2007. *Bureau of Indian Affairs Calculation of Unemployment Rates for Montana Indian Reservations.* Retrieved May 14, 2008, from http://www.ourfactsyourfuture.org/admin/uploadedPublications/1935_IndianLaborMarket_wCSK.pdf

Figure V-4. Average Annual Unemployment Rate, 1990-2007



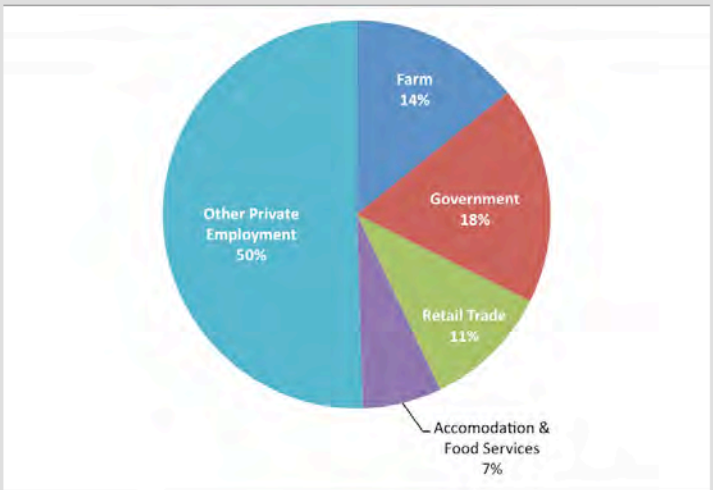
Source: ECONorthwest, with data from U.S. Department of Labor, Bureau of Labor Statistics. 2008. Local Area Unemployment Statistics [for Roosevelt, Prairie, Dawson, Valley, Richland, and McCone Counties]. Retrieved May 1, 2008, from http://data.bls.gov/PDQ/outside.jsp?survey=la

There is no doubt that agriculture plays an important role in the region's economy, but it is not the largest employer in all of the region's counties, nor does it represent a large percentage of the region's total income. Over the years, farm employment and income have remained largely constant, while other sectors of the economy have grown.

Overall, farm employment in 2006 made up about 14 percent of total employment. In the counties that are experiencing the greatest declines in population (McCone and Prairie), agriculture accounts for almost a third of total employment (see Table V-1, below). In the remaining counties, it falls even with or second or third to other industries, such as health care, oil and gas development, and retail trade. For the region as a whole, government (federal, state, and local government) is the largest single category of employment at 18 percent. Eleven percent of the workforce was employed in retail trade, and six percent in accommodations and food services. The remaining 50 percent of workers were employed in other private enterprises, including construction, manufacturing, professional services, transportation, and health care. Figure V-5 shows this break-down.

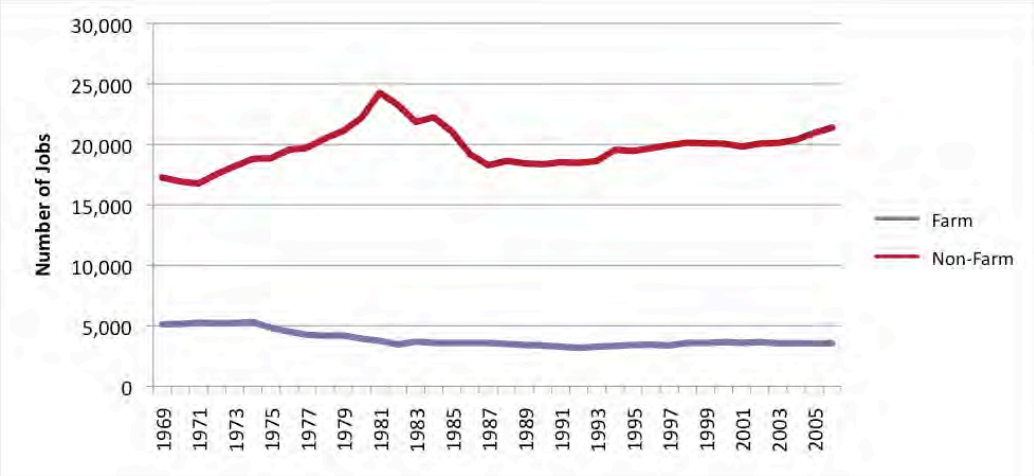
The number of people employed in the region's farm sector did not change between 2001 and 2006, while total employment increased slightly during the same period, with all of the growth in private, non-farm employment. Over the long-term, non-farm employment has grown, while farm employment has declined slightly. As the historical trend in Figure V-6 shows, non-farm employment peaked in the early 1980s, declined through the rest of the 1980s, and has steadily grown through the 1990s and 2000s. In contrast, farm employment dropped off during the mid-1970s and never recovered, remaining steady from about 1981 through the present.

Figure V-5. Employment by Industry in the Region, 2006



Source: ECONorthwest, with data from U.S. Department of Commerce, Bureau of Economic Analysis. 2008. *Regional Economic Information System: Table CA25.* Retrieved May 6, 2008, from http://www.bea.gov/regional/reis/CA25Nfn.cfm

Figure V-6. Trends in Total and Farm Employment in the Region, 1969 - 2006



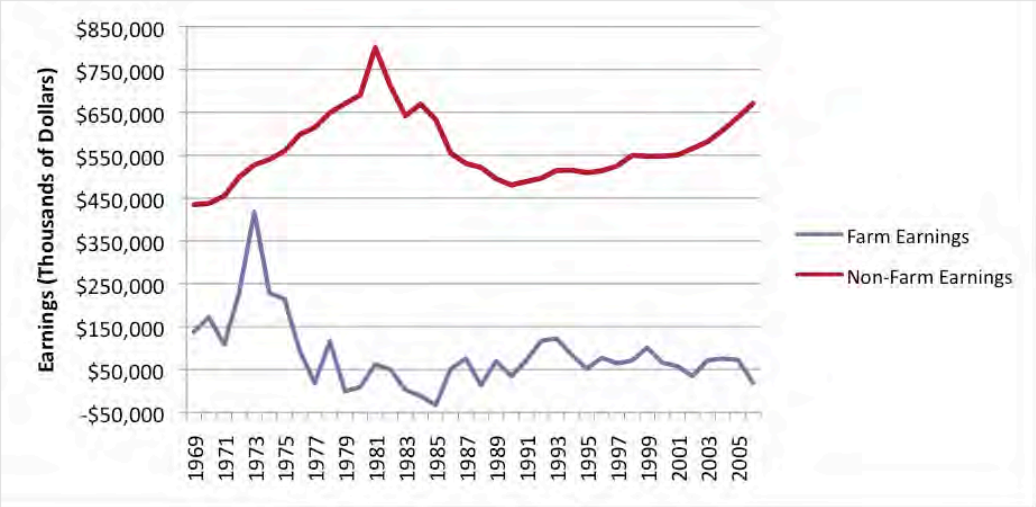
Source: ECONorthwest, with data from U.S. Department of Commerce, Bureau of Economic Analysis. 2008. *Regional Economic Information System: Table CA25.* Retrieved May 6, 2008, from http://www.bea.gov/regional/reis/CA25Nfn.cfm

Personal income in the region was about $1 billion in 2006.[175] Farm earnings were $19.2 million in 2006, and have fluctuated widely, from a high of over $70 million in 2003 (2006 dollars) to their low in 2006.[176] Although farm employment

[175] U.S. Department of Commerce, Bureau of Economic Analysis. 2008. *Regional Economic Information System.* Retrieved June 9, 2008, from http://www.bea.gov/regional/reis

[176] The Bureau of Economic Analysis' Farm Earnings data is comprised of the net income of sole proprietors, partners and hired laborers arising directly from the current production of agricultural

Figure V-7. Farm and Non-Farm Income in the Region from 1969-2006 (2006 Dollars)



Source: ECONorthwest, with data from U.S. Department of Commerce, Bureau of Economic Analysis. 2008. *Regional Economic Information System.* Retrieved June 9, 2008, from http://www.bea.gov/regional/reis

represents 14 percent of the region's overall employment, the income from those jobs represented just 2.8 percent of the region's total earnings in 2006. Between 2001 and 2006, on average, farm income represented closer to 8 percent of the region's total earnings. Since the early 1990s, as Figure V-7 shows, the region's non-farm earnings have grown steadily in recent years relative to farm income, which has fluctuated, but remained largely constant.

B. History of Irrigated Agriculture and Investment at the Study Area

Irrigation development in this case study area generally occurred later than it did in the rest of the state. With a few exceptions, the most notable being the Bureau of Reclamation's lower Yellowstone project, irrigation was not widespread in the case study area until several decades into the 20th century.

In Montana's western valleys, local mountain snowpack, steeper topography and large numbers of perennial tributary streams made it possible for individuals or small user groups to develop literally thousands of relatively simple gravity-fed ditch systems. Most of these systems date back to the 19th century. The lower Yellowstone and lower Missouri presented prospective irrigators with greater challenges. There are few reliable tributary streams to tap into and rely on gravity to "power" irrigation. The gradient of the rivers themselves in this part of the state is sufficiently modest that long ditch systems are required to achieve

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commodities, either livestock or crops. It includes net farm proprietors' income and the wages and salaries, pay-in-kind, and supplements to wages and salaries of hired farm laborers; but specifically excludes the income of non-family farm corporations.

Table V-1. Summary of Demographic and Economic Statistics

	Roosevelt County	Richland County	Dawson County	McCone County	Prairie County	Valley County
Population Characteristics						
Population, 2000	10,620	9,667	9,059	1,977	1,199	7,675
Median Age, 2000	32.3	39.2	41	42.4	48.9	41.7
Percent over 65, 2000	11.6%	15.6%	17.7%	18.9%	24.1%	19%
High School Graduate or Higher, 2000	80.6%	83.5%	82.7%	86.1%	78.8%	83.9%
Bachelor's Degree or Higher, 2000	15.6%	17.2%	15.1%	16.4%	14.8%	15.7%
Economic Statistics						
Per Capita Personal Income, 2006	$21,054	$32,887	$25,925	$22,305	$26,585	$30,258
Percent Below Poverty, 2000	32.4%	12.2%	14.9%	16.8%	17.2%	13.8%
Total Employment, 2006	5,389	7,139	5,605	1,305	701	4,793
Percent Farm Employment, 2006	13.3%	10.4%	10.4%	34.3%	31.8%	17%
Unemployment Rate, 2006	5.7%	2.1%	2.5%	2%	3.1%	3.1%

Source: ECONorthwest, with data from U.S. Department of Commerce, Bureau of the Census. 2008. *American Factfinder Fact Sheets* [for each county]. Retrieved June 9, 2008, from http://factfinder.census.gov; U.S. Department of Commerce, Bureau of Economic Analysis. 2008. *Regional Economic Information System.* Retrieved June 9, 2008, from http://www.bea.gov/regional/reis; and U.S. Department of Labor, Bureau of Labor Statistics. 2008. *Local Area Unemployment Statistics* [for each county]. Retrieved June 9, 2008, from http://www.bls.gov/lau/home.htm

sufficient head and coverage of sizable acreages. Most importantly, the rivers themselves are large, and thus more difficult to manage and control. As a result, a larger percentage of the irrigation on the Yellowstone and Missouri Rivers was historically more reliant on large, capital-intensive projects than on the relatively simple systems that sufficed in much of the western parts of the state

Despite the relatively late start, by the 1950s, much of the readily-irrigable lands located in the river corridors were served by large projects. Surveys by the State Engineer's Office conducted from the 1950s to the early 1970s, which identified both private and project based water use, identified 65,000 acres irrigated by the Yellowstone River and over 20,000 irrigated by the Missouri River within the study area.[177] It appears that those levels of irrigation were essentially sustained

[177] Water Resources Survey: Phillips County. Montana Water Resources Board, Helena, MT. 1970.; Water Resources Survey: Dawson County. Montana Water Resources Board, Helena, MT. 1970.; Water Resources Survey: Richland County. Montana Water Resources Board, Helena, MT. 1971.; Water Resources Survey: McCone County. Montana Water Resources Board, Helena, MT. 1971.; Water Resources Survey: Valley County. Montana Water Resources Board, Helena, MT. 1968.

until the mid 1990s. Over the past 10 or so years, however, there has been a further increase in irrigated lands in this study area.[178]

Most of this increase is not related to the existing large projects, but the result of individual farms and ranches installing pumps on the Yellowstone or Missouri River to serve pivot sprinkler systems. The newly irrigated lands are typically comprised of previously unirrigated river bottom lands, or unirrigated bench lands.[179]

C. Current Status of Irrigated Agriculture and Infrastructure

Irrigated agriculture is currently doing well in this region of Montana. In 2007, 63 pivots systems were installed on the Yellowstone and Missouri corridors by just one of the region's leading suppliers of irrigation equipment. Of those, 80 percent are believed to have been installed on newly irrigated lands. Assuming the typical pivot coverage of 130 acres, this equals an expansion of irrigated land by 6,500 acres in 2007 alone.[180] Other estimates are more modest, ranging from 3,000 to 4,000 acres for the year, but in any case by recent Montana standards, the increase has been appreciable.[181]

The growth seen during 2007 is probably typical of annual growth that occurred annual during the previous years of the decade. The Eastern Plains Resource Conservation Development suggests that in eastern Montana irrigated acres have increased by about 5,000 acres per year since 2001. The main source of water for this growth has been the Missouri and Yellowstone Rivers, so it is like that most of these new acres are located in the case study area.

Some projections for future additional irrigation are, in fact, startling. The USDA's Agricultural Research Service (ARS), Northern Plains Agricultural Research Lab suggests that the area of Western North Dakota and Eastern Montana linked by the Missouri and Yellowstone Valleys have the "potential to easily add at least 500,000 acres of new irrigation."[182] The ARS does not identify the number of those acres that would be in Montana.

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[178] Personal Communication with Dick Iverson, Coordinator Eastern Plains Resource Conservation and Development. May 27, 2008.

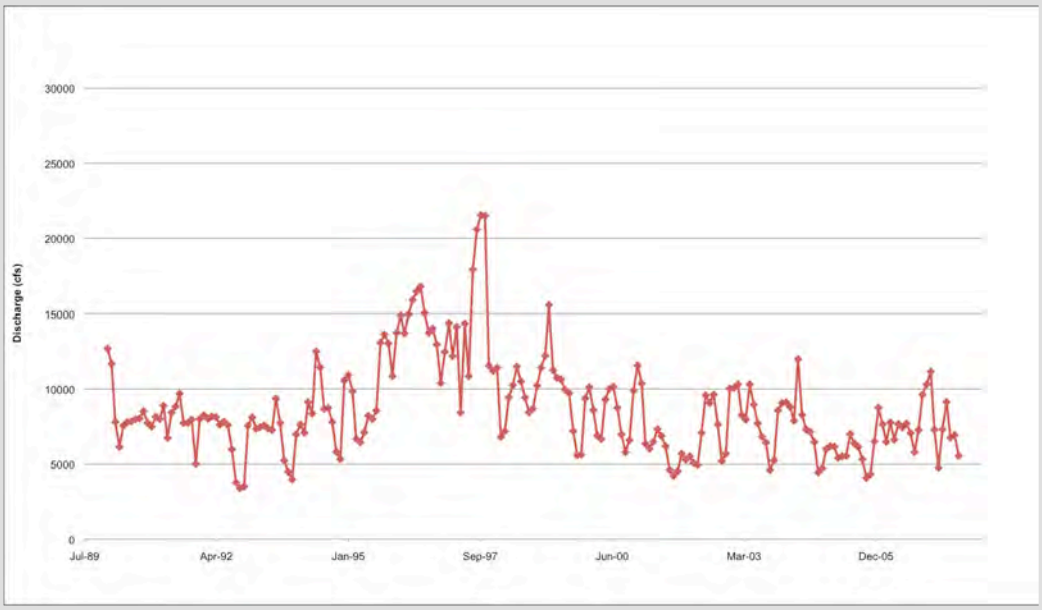
[179] Personal Communication with Pat Riley, Irrigation Development Officer, DNRC – Conservation and Resource Development Division (CARDD). May 22, 2008.

[180] Personal Communication with Mike Ames, Agri Industries, Williston, ND. June 2, 2008.

[181] Personal Communication with Ann Kulczyk, DNRC CARDD specialist, Glasgow, MT. June 2, 2008.

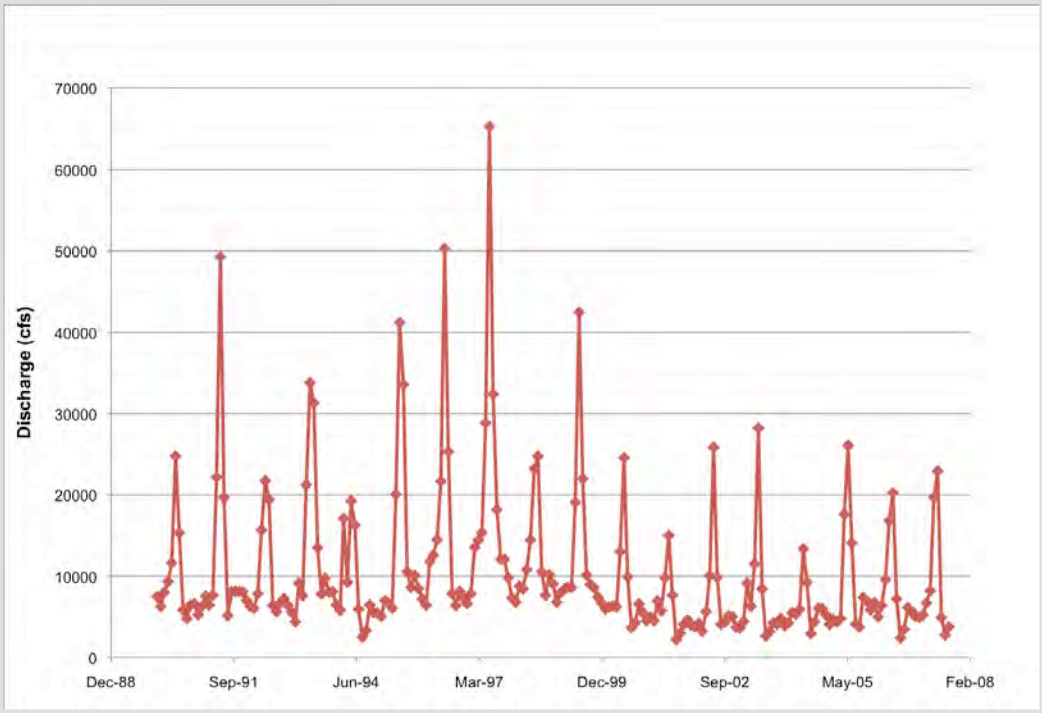
[182] U.S. Department of Agriculture, Agricultural Research Service, North Plains Agricultural Research Lab. 2006. *MonDak Irrigation Overview.* Retrieved June 13, 2008, from http://www.ars.usda.gov/Main/docs.htm?docid=13866

Figure V-8. Missouri River Discharge at Culbertson between 1990 and 2007



Source: USGS. 2008. *National Water Information System [Missouri River Near Culbertson.]* Retrieved June 9, 2008, from http://waterdata.usgs.gov/nwis/uv?06185500

Figure V-9. Yellowstone River Discharge at Glendive and Sidney between 1990 and 2007



Source: USGS. 2008. *National Water Information System [Yellowstone River Near Sidney.]* Retrieved June 9, 2008, from http://waterdata.usgs.gov/nwis/uv?0632950005

In addition, a large amount irrigable land remains available for agricultural development. This land exists both in the river bottoms, and on adjacent, relatively inexpensive bench lands. Available land and water in the study area, combined with the currently high commodity prices and comparatively higher prices for land in other regions of the state, has generated considerable interest in the study area from both regional and national agricultural industries.[185]

Obviously water and land were available for irrigation development in the lower Yellowstone and lower Missouri Valleys before the mid 1990s. But factors have arisen in recent years that have spurred farmers to invest in new irrigation, when they didn't or couldn't before. For example, in the mid-1990s, sugar prices and the existence of a refinery in Sidney drove some of the expansion. In the last few years, new local processing facilities, drought, and rising commodity prices appear to have driven the expansion of irrigated acres. Malt barley has become a very important crop in the area to feed a malt barley processing plant in Sidney. Recent droughts have provided farmers an incentive to reduce their dependence on dryland farming. Finally, due in part to rising commodity prices, farmers in the region have been diversifying into crops and into farming related-operations that require irrigation, such as corn, beans, and potatoes.[186]

This expansion of irrigated land is occurring in the context of a region that already identifies itself as an agricultural area. In addition to processing facilities, there is a well-developed network of commercial and governmental support services for irrigators.[187] A comparison with the Bitterroot Valley case study area is useful here. In the Bitterroot Valley, public discussions of natural resource issues frequently turn, whether correctly or not, on the question of "growth vs. no-growth." The sparsely-inhabited eastern third of the Montana can afford to designate economic growth is a widespread goal, not a source of controversy. In addition, irrigated agriculture is perceived as one of the mechanisms to help grow local economies. In the western portions of the state, there is a tension between a large contingent of recreational users of water ways, and irrigators. In the lower Yellowstone and Missouri, the size of the agricultural economy relative to the recreation economy makes this a much less prominent issue.

The region's distance from major agricultural and urban centers presents both advantages and disadvantages for irrigated agriculture. The distance increases transportation costs for delivering agricultural products to markets, and being more removed from the wide range of services offered in more populated regions may introduce some inefficiencies and added costs into the production process. Both of these factors may reduce the region's farmers' ability to compete

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[185] Personal Communication with Pat Riley. *See* footnote 179.; Personal Communication with Dick Iverson. *See* footnote 178.

[186] Personal Communication with Dick Iverson. *See* footnote 178.

[187] Personal Communication with Pat Riley. *See* footnote 179.; Personal Communication with Dick Iverson. *See* footnote 178.; U.S. Department of Agriculture, Agricultural Research Service, North Plains Agricultural Research Lab. 2006. *See* footnote 182.

with farmers closer to urban centers. On the other hand, distance from urban areas is likely one of the reasons conflicts between irrigated agriculture and other water users are more muted, compared to other regions in Montana. Because of this, irrigators currently encounter little friction as they expand onto new land with new water resources. Some agricultural analysts suggest that the distance of the Lower Missouri and Lower Yellowstone Valleys may actually facilitate expansions of its irrigated agriculture, especially in years to come: geographic isolation will give the area an edge over other regions in growing specialty value-added and high-value crops, such as plant based pharmaceuticals, seed crops, herbs, oil seed crops, vegetables, chemical plant feedstocks, bio-fuels and bio-lubricants.[188]

Most of the agricultural lands in the study area continue to be operated by traditional farmers and ranchers who use the land for the sole purpose of generating income. These types of operations have more incentive to expand irrigation, and generate revenue. In comparison with western Montana, there are relatively few hobby farms or recreational properties in the lower Missouri and lower Yellowstone Valleys. Expansions of irrigated lands, and the associated risks, are less attractive to operations that do not have to be self-sustaining.[189]

It is worth noting that the recent expansion in irrigated agriculture in the study area appears to be continuing notwithstanding some underlying conditions that are not favorable. The cost of pumps, pipelines and pivots has increased in recent years from $1,000 per acre to $1500 per acre, and in locations more far removed from the rivers, to as much as $2,000 to 3,000 per acre.[190] In addition, pumping costs remain high. Only two units of the Lower Yellowstone Project benefit from the lower power rates provided for under the Pick-Sloan Act.[191] Finally, recent years have seen a softening of the sugar prices worldwide, and a reduction of acres of irrigated sugar beets in the study area. At this point, however, other crops, such as malting barley, appear to be rapidly replacing sugar beets.

1. Water Delivery Infrastructure

Unlike the case studies for the Milk River and Greenfields areas, no single project or infrastructure development dominates this area. On the other hand, there is clearly not the profusion of systems and small irrigation projects that exists in the Bitterroot case study area, either. The area reflects a blend of Bureau of Indian Affairs (BIA), Bureau of Reclamation (BOR) projects, private ditch companies, and an increasing number of individual pump systems. What further sets this

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[188] U.S. Department of Agriculture, Agricultural Research Service, North Plains Agricultural Research Lab. 2006. *See* footnote 182.

[189] Personal Communication with Pat Riley. *See* footnote 179.

[190] Personal Communication with Mike Ames. *See* footnote 180.

[191] Personal Communication with Gerry Nyppen, Project Manager, Lower Yellowstone Irrigation Project. June 4, 2008.

case study area apart is that none of the irrigation on the lower Yellowstone or Lower Missouri requires the development of storage reservoirs. Flows in the rivers in the study area are substantial and reliable enough to avoid the cost and impacts of storage reservoirs.

The most prominent single component of the irrigation infrastructure in the case study area is the Intake Diversion Dam, which serves as the means of appropriation of water for the 34,755 Montana irrigated acres of the BOR's lower Yellowstone River Project. The Lower Yellowstone Project also includes the Thomas Point Pumping Plant, the Main Canal, 225 miles of lateral canals, and 118 miles of drains.[192] The Intake Diversion Dam, located about 18 miles below Glendive, is a rock-filled timber-crib weir about 12 feet high. The Main Canal diverts to the west side of the Yellowstone River at Intake and extends down the valley to the confluence of the Yellowstone and Missouri Rivers.

Currently, the Bureau of Reclamation, US Army Corps of Engineers, Montana Fish Wildlife and Parks, US Fish and Wildlife Service, and the Lower Yellowstone Irrigation District are working cooperatively to address fish passage concerns on the Intake Diversion Dam. The fish bypass design will consist of a rock-lined bypass channel that will allow upstream migrating fishes to negotiate their way around the structure. A technical team identified three alternatives for modifying the diversion dam for fish passage. Progress is being made in terms of funding, scoping, and cost estimates.[193] In 2007, Congress authorized the Army Corps of Engineers to spend a portion of its Missouri River Fish and Wildlife Recovery Funds to help support the project, estimated to cost around $40 million.[194]

2. Water Use and Availability

There are fewer legal hurdles to diverting water in the study area than exist in most parts of the state. The water-rights basis for most of the new development in the study area has been the water reservations held by local county-based conservation districts. These rights were reserved from the Lower Yellowstone in 1978, and from the Lower Missouri in 1994 for irrigation purposes.[195]

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[192] U.S. Department of the Interior, Bureau of Reclamation. 2008. *Lower Yellowstone Project*. Retrieved June 16, 2008, from http://www.usbr.gov/dataweb/html/lowyel.html

[193] U.S. Department of the Interior, Bureau of Reclamation. 2008. *Quarterly NEPA Schedule*. Retrieved June 16, 2008, from http://www.usbr.gov/gp/nepa/quarterly.cfm#mtao

[194] The Nature Conservancy. 2007. *Water Resources Bill Authorizes Funding for Intake Dam*. November 8. Retrieved June 11, 2008, from http://www.nature.org/wherewework/northamerica/states/montana/press/press3200.html

[195] Department of Natural Resources and Conservation. 1994. *Final Order of the Board of Natural Resources and Conservation Establishing Water Reservations, 1994*. Retrieved June 13, 2008, from http://dnrc.mt.gov/wrd/water_mgmt/water_reservations/lower_missouri_riv_basin/default.asp; and Department of Natural Resources and Conservation. 1979. *Final Order of the Board of Natural Resources and Conservation Establishing Water Reservations, 1979*. Retrieved June 16, 2008, from http://dnrc.mt.gov/wrd/water_mgmt/water_reservations/yellowstone_riv_basin/default.asp

Conservation districts in the study area were proactive in securing these rights for future irrigation projects.

The availability of this reserved water has proven to be a boon to irrigators in this case study area. In much of the rest of the state, various closures and court rulings have combined in recent years to effectively preclude new appropriations of water. However, there are relatively few legal obstacles to appropriating water from the Lower Missouri and Lower Yellowstone, and this has probably contributed to the expansion of irrigated land.

At the time they were established, the reserved rights in the study area were largely designated by the conservation districts for the bench lands immediately alongside the river corridor. These have in fact proved to be the locations where much of the expanded irrigation is now occurring.[196] The relative ease with which the reserved rights make it possible to obtain water rights for these bench lands stands in contrast to the Milk River study area, where water rights constraints and Bureau of Reclamation procedures effectively preclude benchland irrigation even if it were to rely on the relocation of existing water rights.

Another element of the reserved rights acquired by the conservation districts that is beneficial to irrigators is their reliability during low-flow periods. In the upper Yellowstone, (above the confluence of the Bighorn River) the reserved rights obtained by conservation districts were subordinated to the instream reserved rights held by the Montana Department of Fish, Wildlife and Parks. As a result, irrigation developed in the upper river based on those rights typically has to cease by mid July as natural stream flows drop.[197] In contrast, Conservation District Reserved Rights in the lower basin can be legally exercised throughout the irrigation season.[198] The same situation exists on the Lower Missouri, where instream flows are subordinated to the reserved rights acquired for irrigation by the local conservation districts.

In the larger picture, the Conservation District rights are not particularly senior. Most of the irrigation development in the case study area, and in locations upstream from the study are, and as a result the associated water rights, predate the 1978 priority dates of the Lower Yellowstone reservations and the 1994 date of the Lower Missouri reservations. However the flows in both rivers have been sufficient to make both priority dates effective, and have provided uninterrupted use of water for those using water under them.

Allocation data regarding use of conservation district reserved rights suggests both the utility of the reservations, and relatively high demand for irrigation

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[196] Personal Communication with Pat Riley. *See* footnote 179.

[197] Personal Communication with Pat Riley. *See* footnote 179.

[198] Personal Communication with Dick Iverson. *See* footnote 178.

water in this case study area. As Table V-2 shows, Conservation District Reserved Rights in this case study area comprise 32 percent of the total volume, in acre feet, of the reserved rights held by conservation districts statewide. Similarly, 31 percent of the approved projects for those rights have been in this case study area. However, the rate of allocation of conservation district reserved rights in the case study area greatly exceeds the rate for the rest of the state. The 77 approved projects in the case study area call for over 60,000 acre feet, representing 21 percent of the total volume of the local conservation districts' available reserved rights. The allocation rate in the remainder of the state is 7.2 percent, or roughly 1/3 of the allocation rate in the case study area.

The reserved rights held by the Fort Peck Tribe may also play a key role in future expansions of irrigated acres in the study area. Two irrigation projects currently planned by the tribe, the Fort Kipp and North Sprole, would rely on Tribal reserved rights (for more detail, see *Technical Memorandum 1.2/1.4 – Availability of Land and Water Resources and Crop Type by Basin)*. The senior priority dates of the tribe's rights will assure that water supplied to the projects under those rights very reliable.

The current and potential utilization of tribal and conservation district reserved rights makes the as-yet-uncompleted adjudication of water rights by the Montana Water Court less of an obstacle to water development. In contrast with the Milk, Bitterroot, and many other basins in the state, it is not necessary to acquire and relocate historic water rights in this case study area in order to irrigate new acres. In addition, the relative substantial and reliable river flows, and the resulting lack of competition between senior and junior rights makes the absence of administrable water rights decrees a less significant issue on the mainstems of the Yellowstone and the Missouri Rivers than it is in other basins in the state.

Table V-2. Comparison of Conservation District Reserved Rights in the Study Area with the Rest of Montana

	Case Study Counties	Non-Case Study Counties	Statewide Reservations
Number of Approved Projects	77	172	249
Total Reservation Volume (ac-ft)	280,373	600,172	880,545
Volume Allocated to Projects (ac-ft)	60,074	43,432	103,506
Volume Remaining (ac-ft)	220,299	556,740	777,039
Volume Allocated (%)	21	7	12
Volume Remaining (%)	79	93	88
Average Volume per Project	780	253	416

Source: Personal Communication with Ann Kulczyk, DNRC CARDD specialist, Glasgow, MT. June 2, 2008; and Personal Communication with Pat Riley, Irrigation Development Officer, DNRC – Conservation and Resource Development Division (CARDD). May 22, 2008.

D. Proposed or Recent Investments

Several of the potential new irrigation projects described in Technical Memoranda 1.2-1.4, 2.4, and in the preliminary draft report of this study are located in this case study area, including the North Sprole, Fort Kipp and West Crane projects. The discussion above, including the challenges related to pumping are relevant to the future success of these proposals. For more information on these projects, see the Technical Memoranda.

E. Goods and Services Affected by Irrigation

1. Primary Goods and Services

The application of irrigation water to crops produces economic benefits in two ways: by increasing the yield of a crop that was previously cultivated without irrigation, or by enabling a farmer to grow a higher-valued crop. Both of these strategies are at play in the lower Missouri and lower Yellowstone Valleys. For example, in 2003, Richland County ranked third in the state for growing sugar beets, a crop that can be grown in the region only with irrigation; in 2002, it produced over one-third of the state's entire crop of sugar beets. Much of the irrigated land in the valleys is dedicated to alfalfa and hay production, and irrigation increases the yields of these crops compared to growing them without irrigation. Farmers who produce these irrigate crops are likely to earn more net income (crop revenues minus the costs of producing the crop) than they would if they farmed without irrigation. Thus, they are likely to be willing to pay more for irrigated land than non-irrigated land, so the added value of irrigation is likely to show up in higher land values for irrigated land.

Net Income. We are unaware of any data to determine the effect of irrigation on the net income of farms in the lower Yellowstone and lower Missouri River corridors. However, the total net farm income in the region appears to be strong: with the exception of income in 2006, which was negative for most parts of Montana, and the state as a whole, net income from farms has been positive for each year over the last decade.[199] In 2002, farms that reported net gains outnumbered farms that reported net losses by almost two-to-one, and the average net gains for farms were double the average net losses.[200]

Land Values. Although the amenities of wide open spaces and large undeveloped river bottoms and world class hunting opportunities have begun to

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[199] U.S. Department of Commerce, Bureau of Economic Analysis. 2008. *Regional Economic Information System.* Retrieved June 9, 2008, from http://www.bea.gov/regional/reis

[200] U.S. Department of Agriculture, National Agricultural Statistics Service. 2004. *2002 Census of Agriculture: Montana State and County Data.* Volume 1, Geographic Area Series Part 26. Report No. AC-02-A-26. June.

raise land prices in eastern Montana,[201] especially land adjacent to the Yellowstone River,[202] it is an area where the goal of passing a farm and ranch on to the next generation remains reasonable and viable. Much of the farmland in the region is still appraised using traditional production-based equations: the income and cost approaches to determining value still have relevance in eastern Montana.[203] Appraisers of agricultural land confirm that irrigation adds considerable value to land in this part of the state. Values vary slightly, depending on the region, but in general, an acre of irrigated land in the lower Yellowstone Valley is around 7 times more valuable than an acre of rangeland, and about 5 times more valuable than an acre of dry cropland. In the lower Missouri, the differences are about the same, perhaps slightly less.[204] Overall, prices are highest in the lower Yellowstone Valley, where an acre of non-irrigated land may be valued between $350 and $475, while an acre of high-quality irrigated land may be valued around $2,000, but can go as high as $4,000.[205] Irrigated land along the lower Missouri River, particularly around Wolf Point tends to be of lower quality, with mixed soils, and therefore less valuable than land along the lower Yellowstone. For example, the value of an acre of irrigated land in this area may be $750 to $1,250. Irrigation delivery reliability also influences the value of irrigated land: the Buffalo Rapids and Lower Yellowstone projects have a reputation for reliability and good maintenance, and land prices in these areas are higher to reflect that. In contrast, land served by the Fort Peck Irrigation Project is less valuable due in large part to less reliable water delivery.[206]

The recreational buyers in the market for land have begun to influence land prices in eastern Montana around the lower Yellowstone and lower Missouri Rivers, especially in the last 2 to 6 years. The influence is greatest adjacent to the rivers and in upland areas where large game are present.[207] However, there are still many areas that have less appeal for amenity buyers, particularly on the bench lands above the river valleys. In these areas, non-irrigated land is readily available at prices that easily support agricultural development.

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[201] Breining, G. 2006. "Farmlands Becoming Grounds for Hunters." *New York Times*. November 24. Retrieved May 14, 2008, from http://travel.nytimes.com/2006/11/24/realestate/greathomes/24havens.html

[202] Norman C. Wheeler & Associates. 2006. *For Lands Sake: Annual Montana Land Study*. Retrieved April 30, 2008, from http://www.ncwheeler.com/newsletters/2006_for_lands_sakes.pdf

[203] Norman C. Wheeler & Associates. 2006. *See* footnote 202.

[204] Personal communication with George Luther, Luther Appraisal Services. May 29, 2008.

[205] Personal communication with Phyllis Sethre, Appraiser, Wolf Point, MT. May 29, 2008.

[206] Personal communication with Phyllis Sethre. *See* footnote 205.

[207] Personal communication with George Luther. *See* footnote 204.

2. Complementary Goods and Services

Irrigation in the lower Yellowstone and lower Missouri River Valleys is accomplished without the aid of large storage reservoirs. Although several diversion dams span the main stem of the Yellowstone River to divert water for irrigation, they provide fewer complementary goods and services than many irrigation reservoirs provide, such as hydropower, municipal and industrial water storage, and lake-based recreation. However, the irrigation activities in the Lower Yellowstone and Lower Missouri River Valleys do produce some complementary goods and services, associated with the Intake Diversion Dam, and habitat created by the water spread across many acres of farmland.

Recreational Opportunities. The Intake Diversion Dam, located 18 miles downstream of Glendive in Dawson County is also a fishing access site on the lower Yellowstone River, administered by Montana FWP. In addition to access to the river for boaters and anglers, the site provides primitive campsites, and opportunities for hiking, picnicking, and wildlife watching. The lower Yellowstone River from the North Dakota border to the Powder River is a popular fishing area. Montana FWP classifies this stretch of river as a class I "blue ribbon" fishery. As a warm-water fishery, the lower Yellowstone provides anglers the opportunity to catch warm-water fish, such as walleye, pike, catfish, sturgeon, paddlefish, and burbot.[208]

In particular, the Intake Diversion Dam is known for being the best place in the state to fish for paddlefish, an ancient fish that migrates up the lower Yellowstone River during the spring to spawn. During late May or early June, the paddlefish collect below the dam, and over 3,000 anglers come to Intake from across the region to participate in this brief but tremendously popular and unique fishing opportunity.[209] During other parts of the year, the Intake fishing access site is noted for having excellent sturgeon, walleye, catfish, and sauger fishing.[210] The reach of lower Yellowstone River downstream of the Powder River supported an average of over 17,000 fishing days each year between 1999 and 2005.[211] The U.S. Fish and Wildlife Service estimates that state-resident anglers place an average net economic value of $54.80 per day for trout, bass, and walleye fishing,[212] and out-of-state anglers places even more value, $91.20 per

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[208] Benke, A.C. and C.E. Cushing. 2005. *Rivers of North America.* Burlington, MA: Elsevier Academic Press.

[209] The effect on the paddlefish fishery of the current project to add fish passage structures to Intake Dam, which we discuss earlier in this case study, remains unknown, but it is possible that it will reduce the importance of this site for recreational anglers.

[210] Montana Fish, Wildlife, and Parks. 2008. *Paddlefish of the Yellowstone and Missouri Rivers.* Retrieved June 11, 2008, from http://fwp.mt.gov/fishing/fishingmontana/brochure_paddlefish.html

[211] Montana Fish, Wildlife, and Parks. 2008. *Montana Fishing Guide: Yellowstone River.* Retrieved May 13, 2008, from http://fwp.mt.gov/fishing/guide/

[212] U.S. Department of the Interior, Fish and Wildlife Service. 2003. *Net Economic Values for Wildlife-Related Recreation in 2001: Addendum to the 2001 National Survey of Fishing, Hunting, and Wildlife-*

day, on such an experience. To the extent that the Intake Diversion Dam increases the number of angling days on the Yellowstone River and provides unique fishing opportunities, it generates value for the region. The paddlefish fishery at Intake alone likely generates a net economic value in excess of $160,000 each year—and this number is probably an underestimate, due to the uniqueness and popularity of the paddlefish season.

3. Competing Goods and Services

At first glance, it may be difficult for many to identify competing demands for water in this remote region of eastern Montana. The rivers are large and have reliable flows throughout the year. Irrigated agriculture represents 90 percent of the water use within the Yellowstone River Basin, and the amenity and recreation-based economies are not as robust as in other parts of the state. However, taking a broad view of the types of goods and services the Rivers provide reveals that irrigation development may compete with the production of some goods and services. Many of these goods and services are not typically recognized as providing economic value, and their values have historically not been carefully measured.[213] That does not mean that they do not provide economic value, nor should they be minimized or ignored.

The lower Yellowstone and lower Missouri Rivers represent unique ecosystems that have intrinsic economic value due to their relative scarcity in the west. For example, the Yellowstone River is the only large river in the west that has no main-stem storage or hydroelectric dams; it is the longest free-flowing river in the continental United States. Although there are several cross-channel water diversion structures in the lower Yellowstone, the river's flow remains mostly unaltered. Large irrigation reservoirs have been proposed for the river in the past, but so far have not been built. Research suggests that the River's unaltered flow is a valuable natural laboratory for understanding how large western rivers function, and applying lessons learned to mitigation and restoration efforts on other similar rivers, such as the Missouri. Another example stems from the areas of remnant riparian cottonwood habitat that can be found along the lower Missouri and lower Yellowstone rivers. Because much of the land throughout the river corridors, and in fact, throughout the entire Missouri basin, has been disturbed by development and agriculture, any remaining patches of natural habitat will continue to grow in value as development pressures continue to shrink the supply of these resources. A report by the National Research Council on the Missouri River Ecosystem suggests that these remnant areas of natural vegetation will be critical in future efforts to restore the floodplain ecosystem

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Associated Recreation. Report No. 2001-3. September. Retrieved May 14, 2008, from http://library.fws.gov/nat_survey2001_economicvalues.pdf We have converted the value to 2007 dollars.

[213] National Research Council, Division on Earth and Life Studies, Water Science and Technology Board, Committee on Missouri River Ecosystem Science. 2002. *The Missouri River Ecosystem: Exploring the Prospects for Recovery.* Washington D.C.: National Academy Press.

throughout the Missouri basin.[214] Should new irrigation development in the lower Missouri and lower Yellowstone Valleys displaces these last areas of natural habitat, society will loose increasingly valuable resources.

The Intake Diversion Dam is one of several cross-channel water diversion structures that divert water from the Yellowstone River for several irrigation projects in the region. Depending on the time of year, the Intake Diversion Dam diverts up to half of the river's flow,[215] creating a barrier to fish traveling upstream when the river is low. Because the dam has no fish screen or fish passage structures, fish are diverted with the irrigation water and become stranded in the irrigation canal networks.[216] Montana FWP estimates that at least 500,000 fish meet their end in the Intake canal each year, and many of these are popular game fish. A study by the Bureau of Reclamation found that at least 70,000 sauger over 8 inches long die in the Intake irrigation canal each year. Fishery managers with the Montana FWP estimate that this translates into a loss of fishing opportunity for over 10,000 anglers in the lower Yellowstone at the Intake fishing site.[217] Assuming that the net economic value of a fishing day in the lower Yellowstone is approximately $55, that represents a potential loss in recreational fishing value of $550,000 each year.

The Intake Diversion Dam also impacts the population of several sensitive, threatened and endangered species, including the pallid sturgeon and the paddlefish. The lower Yellowstone has some of the nation's best remaining pallid sturgeon habitat, and scientists estimate that there are fewer than 200 left in the river.[218] The lower Missouri is also important habitat for the sturgeon. Economic literature shows that society places a high value on the continued existence of endangered species. No specific studies exist on the specific value of the survival of the pallid sturgeon or the other sensitive species in the lower Yellowstone and lower Missouri Rivers. However, in a 2005 study of the economic benefits of flows in the Milk River, which provides some spawning habitat as well as warm water flows that improve the sturgeon's habitat in the lower Missouri, economists estimated a national benefit of about $4.6 billion (2005 dollars) for the continued survival of the pallid sturgeon, based on studies of other endangered

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[214] National Research Council, Division on Earth and Life Studies, Water Science and Technology Board, Committee on Missouri River Ecosystem Science. 2002. *See* footnote 206.

[215] Dickson, T. 2005. "Little Dams, Big Barriers." *Montana Outdoors.* May-June. Retrieved May 15, 2008, from http://fwp.mt.gov/mtoutdoors/HTML/articles/2005/DiversionDams.htm

[216] As we discuss earlier in this case study, a project is underway to add fish passage structures to Intake Dam. Once these structures are complete, the impact of the dam on fish populations will likely be considerably reduced.

[217] Dickson, T. 2005. *See* footnote 215.

[218] Dickson, T. 2005. *See* footnote 215. *See* also The Nature Conservancy. 2007. *Water Resources Bill Authorizes Funding for Intake Dam.* November 8. Retrieved June 11, 2008, from http://www.nature.org/wherewework/northamerica/states/montana/press/press3200.html

fish in the west and midwest.[219] The actual value relevant to the lower Missouri and lower Yellowstone rivers would depend on how significant the habitat provided would be for preventing the extinction of the sturgeon. Given the magnitude of the likely value people in the United States place on its continued survival, however, the value relevant to the lower Missouri and lower Yellowstone Rivers is probably considerable.

4. Trends and Factors Influencing Goods and Services

Those familiar with the market for land in this part of the state expect to see more interest from buyers interested in purchasing property for recreational and amenity purposes in the years to come.[220] While these buyers may not cause land prices to increase quite as much as they have in western Montana, they will put upward pressure on the market—especially on properties adjacent to the Rivers. In other places in the state, the result of this pressure has been fewer viable opportunities to bring more land into agricultural production. It is not clear whether this outcome will manifest in eastern Montana any time soon, but there aren't signs of this occurring today. Currently, many recreational and amenity buyers do not take land out of production, so the effect on the larger agricultural economy may also have less of an effect on the ability to maintain agricultural services and maintain irrigation infrastructure than parts of western Montana have experienced. However, higher concentrations of these kinds of land owners will bring change to the region, including a more acute awareness of threats to the amenities that drew them to the area in the first place. They may place higher value on protecting scenic views, water quality and fishing conditions, and high-quality habitat for large game. In some instances, these values may conflict with the goals of increasing irrigated agriculture in the region.

Other factors, such as fluctuating commodity markets and the rising cost of inputs to agriculture, such as fuel and fertilizer, will add additional uncertainty and potentially challenges to the continued expansion of irrigation in the region. Pumping costs will rise with fuel costs, and the distance from major markets may put the region's farmers at a comparative disadvantage as transportation costs continue to rise. Finally, climate change will have an effect on the region's agriculture, although the effect may be less noticeable here than in many other regions of Montana that depend directly on runoff from mountain snowpack for much of their spring and summer flows. Nevertheless, warmer average temperatures, more frequent heat waves, and warmer nights will increase the demand for water in the region, requiring farmers to apply more water per acre of crop. Current water supplies may be sufficient to cover this increase in demand in many years, but uncertainty abounds.

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[219] Bioeconomics. 2006. *St. Mary Diversion & Milk River Project Preliminary Economic Analysis, Impacts and Benefit-Cost Analysis*. Phase II, Task 4 – Economic Analysis. Final Report. August 30.

[220] Personal conversation with George Luther. *See* footnote 204.; and personal conversation with Phyllis Sethre. *See* footnote 205.

The location of the case study area on the downstream reaches of two large rivers has historically meant, and currently continues to mean, that the addition of adequate infrastructure predictably translates into an abundant supply of water. However, the case study area's downstream location also makes it more vulnerable to increases in upstream water use, a vulnerability that irrigated areas located near headwaters (such as Greenfields), do not typically face. For example, flow data for the Yellowstone at Sidney suggest that streamflows occasionally drop sufficiently low that upstream water development of the portion of the Yellowstone Basin lying in Wyoming could have impacts on late season availability. The Crow Tribe has at various times considered increasing irrigation as well as coal development on the Crow Reservation, all of which would occur at upstream locations. Finally, the interface between the federal endangered species act and state based water rights has not yet been conclusively settled. Current water availability in the case study area is very good, but it should not be assumed that status will extend indefinitely into the future.

F. Summary and Expectations for Future Investments

Irrigated agriculture is generally more robust economically in this region than in other parts of the state. It is expanding, with more expansions being planned, in part because water supplies are available for appropriation, land is relatively inexpensive and available, and, perhaps, because there is some sense of urgency in using water in Montana before it flows into North Dakota. Although irrigation in the region faces some challenges, many of them common to other agricultural areas across the state, the general outlook for the region expressed by irrigators, businesses that support irrigation, and others in the agricultural industry, appears to be positive.

The availability of land and water resources for irrigated agriculture is probably the strongest reason for irrigated agriculture's recent and planned expansion in the region. Bench and bottom lands adjacent to both the lower Missouri and lower Yellowstone Rivers are readily available at prices that production agriculture can support. The water rights the state reserved for irrigated agriculture are available from the region's conservation districts, and the Rivers' relatively dependable flows allow irrigators to plan on reliable water delivery from year to year. Other factors, such as demand for malting barley from a new processing plant in the region, record prices for other irrigated crops, such as corn and oil seeds, and more frequent droughts in the region, which have increased the risk associated with dryland crop production, are making irrigation an increasingly attractive option for the region's farmers.

Several factors may present challenges for continued expansion. Rising costs of irrigation equipment and mounting fuel costs, which raise the cost of pumping and water delivery, increase the overall costs of irrigated agriculture relative to dryland farming. Rising fuel costs also impact the cost of transporting crops. The region is one of Montana's most remote agricultural centers, and although the region is well-connected to these centers by major interstate highways and rail

connections, farmers may have trouble competing with farmers producing crops closer to markets due to the increasing cost of transportation.

Fuel costs notwithstanding, agricultural promoters in the region point out that the region's remoteness may actually provide a comparative advantage over other agricultural regions in years to come. The geographic isolation, dry climate, and relatively reliable water supply and water-management infrastructure may give the region an edge in producing emerging value-added and high value crops, such as plant-based pharmaceuticals, oil seed crops, chemical plant feedstocks, and bio-fuels. Also, as land prices and competition for water continue to increase in other traditional agricultural areas closer to urban centers (see, for example, the Greenfields and Bitterroot Case Studies), farmers from these regions may increasingly look to the lower Yellowstone and lower Missouri region as a place where agricultural production remains a viable commercial enterprise.

Irrigation in the lower Missouri and lower Yellowstone Valleys produces both positive and negative externalities. Irrigation in the region is accomplished without the aid of large storage reservoirs, but several diversion structures and canals draw water from the rivers. These create negative externalities insofar as they block fish passage upstream and capture fish, which become stranded in irrigation canals and ditches. Many of these stranded fish would otherwise contribute to the ecosystem's overall productivity and provide fishing opportunities for anglers on the lower Yellowstone and lower Missouri Rivers, both high-quality warm-water fisheries in Montana. Irrigation and its associated infrastructure also produce positive externalities. In particular, the Intake Diversion Dam, which serves as a fishing access site on the lower Yellowstone River, concentrates paddlefish in the stretch of river below the dam, creating a unique and popular opportunity for anglers to fish for this relatively rare, ancient species.

Future investments in irrigated agriculture in the region may continue to bolster the region's economy. In particular, the planned modifications to the Intake Diversion Dam will almost certainly increase the level of goods and services provided by the region's water resources related to recreation and fish and wildlife habitat, by preventing sport fish from becoming entrained in irrigation infrastructure and opening up new stretches of the river upstream to migratory fish, including some that are currently listed as threatened or endangered. Expansion of irrigation should allow farmers to explore new opportunities for generating revenue by growing new crops, especially emerging high-value and value-added crops, and continue to add considerable value to property in the region.