IRRIGATION IN MONTANA:
A PRELIMINARY INVENTORY OF INFRASTRUCTURE CONDITION

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1.0 Executive Summary

The 60th Montana State Legislature approved funding to prepare an inventory of irrigation infrastructure in Montana. The purpose of the inventory is to provide the Montana Department of Natural Resources and Conservation (DNRC) and other decision makers with an understanding of the condition of existing irrigation systems throughout Montana and an estimated cost of completing necessary improvements. Many irrigators, agency personnel and others recognize that there are irrigation systems throughout the state that are in poor condition. Because irrigated agriculture is of significant value to the state economy, the Montana State Legislature has directed the DNRC to investigate the extent to which the State's irrigation systems require repair.

This inventory included four main components:

- Summary of existing information;
- Mail survey sent to irrigation water supply organizations;
- On-site evaluation of irrigation systems; and
- Development of a Geographic Information System (GIS) database.

The summary of existing information describes the condition of the United States Bureau of Reclamation (USBR) irrigation projects in Montana which together serve over 365,000 acres of irrigated land. The investigation revealed that there are some major issues with a few of the USBR projects. Major components of the Milk River/St. Mary's system are in very poor condition. Estimated repair costs will exceed $150 million. The Huntley Project is aging and is in need of repairs. The Bitter Root Project has issues with critical system components that are estimated to cost over $6 million to replace. Other USBR projects are in good condition including the Lower Yellowstone Project, Buffalo Rapids Project and the Greenfields Division of the Sun River Project. Together these three projects serve over 100,000 irrigated acres.

Irrigation projects owned by the State of Montana and operated by the DNRC are also described in the summary. The State owned projects include ten canal systems that include approximately 250 miles of canal and twenty dams that deliver over 293,000 acre-feet of water. The State projects are not as old as some of the USBR projects such as the Huntley Project and the Milk River Project which are now over 100 years old. Over the past five to ten years, more than $90 million dollars has been invested into repair and rehabilitation of State dams and canals. State Water Projects Bureau personnel estimate that approximately $50 million needs to be spent in the next five to ten years to maintain the integrity of the dams and canals.

The second phase of the inventory included obtaining a list of irrigation water supply organizations, developing a questionnaire and mailing, and compiling the responses. DNRC personnel developed the initial list of known irrigation water supply systems. PBS&J worked in collaboration with the DNRC to develop the survey questionnaire and PBS&J compiled the results. The list of irrigation water supply organizations and the results of the survey became part of the GIS database. The survey was sent to 229 irrigation water supply organizations and replies were received from 81 of those recipients. Approximately one-third of the respondents indicated that one or more components of their irrigation systems are impaired. It is estimated that $131.7 million would be needed to correct impairments statewide. This would be in addition to the amount of money needed for the USBR and State owned systems.

The third phase of the inventory was on-site evaluation of ten different irrigation systems. An effort was made to choose systems in various locations and of various sizes. The intent of the physical evaluations was to help determine if the responses to the mail surveys were accurate. Detailed system analysis was not the intention. Eight out of the ten sites that were visited exhibited noted impairments. One site was only operable during high water and another had a diversion structure that was operating but was extremely deteriorated. The on-site evaluations indicated that the mail survey responses might be understating the incidence of infrastructure impairments.

The final phase of the inventory was the development of a GIS database. The database was compiled from various existing data sources including the irrigation water supply organization list mentioned above, digital data developed by the DNRC from the State Engineer's Water Resources Surveys, the National Hydrography Dataset and other sources. The database includes locations of all the ditches for the systems that either responded to the mail survey or were physically inspected. In addition, the locations of all USBR and State owned projects are included. The DNRC will be the repository for the database. Hopefully, efforts will be made to add to the information. This could be a useful tool to help prioritize funding decisions and answer questions about the state's existing irrigation infrastructure.

The goal of this project was to assess the general condition of irrigation infrastructure in Montana and arrive at an estimate of the amount of money needed to bring the state's irrigation infrastructure to full operating condition. Based on the information gathered in the survey, it is estimated that $343 million is needed to repair all the irrigation infrastructure associated with private systems, irrigation water supply organizations, USBR projects and State owned projects. It is recognized that several Bureau of Indian Affairs (BIA) projects are also in need of extensive repairs; however, cost estimate information for these systems was not available for use in this inventory. If the BIA projects were included, this total would likely be much higher.

This inventory should be considered a first step towards identifying irrigation infrastructure problems. The survey questionnaire that was developed for this effort could be modified and used as a tool to continue to monitor the condition of the state's irrigation systems.

2.0 Introduction

2.1 Purpose and Scope

The purpose of the study is to provide the Montana Department of Natural Resources and Conservation (DNRC) and other decision makers with an understanding of the condition of existing irrigation systems throughout Montana and an estimated cost of completing necessary improvements. Many irrigators, agency personnel and others recognize that there are irrigation systems throughout the state that are in poor condition. Because irrigated agriculture is of significant value to the state economy, the Montana State Legislature has directed the DNRC to investigate the extent to which our irrigation systems require repair.

Irrigators, the DNRC and decision makers will all benefit in multiple ways from this project. Personal contact with the irrigators has raised their level of awareness that the State is interested in their situation. The DNRC will benefit from having a better understanding of the multitude of water supply organizations that exist and having improved information about where these organizations are located and how to contact them. This study will provide decision makers with photos and detailed descriptions of a sampling of irrigation systems across the state. Those who do not have much familiarity with the state's major irrigation structures will gain a better understanding of the complexity of some of these systems and the large land areas that are served. The contrast between large and small systems will also be enlightening.

The original scope of work for this project identified the need for: (1) a summary of existing information, (2) a mail survey sent to approximately 300 irrigators and (3) evaluation of twenty systems. At the "kick-off" meeting in April 2008, it was determined that more emphasis would be placed on the mail survey and on compiling and updating existing information and less emphasis would be placed on site evaluations. To that end, a detailed mail survey was developed and was ultimately sent to approximately 250 irrigation water supply organizations. The geographic information systems (GIS) data provided to PBS&J by the DNRC was updated and a database of irrigation water supply organization contact information and ditch names was created.

Ten separate systems were visited for site evaluation. These were selected with the goal of obtaining a good geographic representation. Availability of irrigation system managers and operators played a role in the selection of sites that were visited.

3.0 Overview of Irrigation in Montana

3.1 Brief History of Irrigation Water Use

The first irrigation by white settlers in what is now the State of Montana occurred at the St. Mary's Mission near present day Stevensville in Ravalli County. It is believed that the Jesuits who founded the mission first irrigated potatoes, wheat and oats with the waters of Burnt Fork Creek in 1842.[2] The Jesuits closed the mission in 1850 and sold the property to Major John Owen. The first irrigation water right in the state, with a decreed priority date of 1852, is attributed to Owen.

Agriculture and irrigation in western Montana grew along with the mining industry and the coming of the Northern Pacific Railroad. For example, irrigation in the Gallatin Valley was largely spurred on by mining. Discovery of gold in Bannack and Virginia City brought hoards of prospectors to the area. Many found themselves unable to secure mining claims and turned to farming the fertile Gallatin Valley lands instead. One of the oldest ditches in the valley is the Mammoth Ditch which was first used in 1866.[3] Lieutenant Gustavus C. Doane's report to the US Senate regarding the Yellowstone Expedition of 1870, described the Gallatin Valley in the following manner; "Its bottom lands are grown up with cottonwood, and its waters afford irrigation to fertile farms, which already support a population of over two thousand."[4]

In the Yellowstone Valley near Billings, the Big Ditch, originally called the M & M Canal, opened in 1883. Irrigation in this valley became more important after the "hard winter of 1886-1887" when some cattle and sheep ranchers reported losses of more than 50% of their herds.[5] After 1887, open range grazing gradually declined and ranchers began keeping smaller herds on fenced ranges and feeding the animals over the winter. The availability of relatively cheap water from the Big Ditch made irrigation of hay and other crops a very attractive prospect. In an article published in the New York Times in 1889, B.F. Shuart, a Billings area sheep rancher, reported having put up 300 tons of alfalfa hay from his 50 acre field.[6] He also grew wheat, oats, corn, potatoes, small fruits, melons and squash. All these crops were irrigated with water from the Big Ditch.

North-central Montana was one of the last areas of the state to be settled. The first irrigation from the Milk River was developed by Robert Trafton in 1888.[7] While irrigation from the Milk worked well during high flows, the inconsistent nature of the water supply did little to encourage large scale irrigation operations. One of the first projects to be authorized by the Bureau of Reclamation (USBR) after its formation in 1902 was the Milk River Project.[8] Construction on this extensive project began in 1907 and continued for the next 40 years. The project serves approximately 121,000 acres of irrigation.

The Homestead Act of 1862, the Desert Land Act of 1877 and the Carey Land Act of 1894 played major roles in the settlement of the west and particularly in the development of agriculture. The Homestead Act required a claimant to settle on and cultivate 160 acres of land for five years in order to obtain the deed to the property. The Desert Land Act allowed a person to acquire an entire section of land – 640 acres – for $1.25 per acre on the condition that they "reclaim" the land by irrigating a portion of it. There were challenges to be sure, as only about 40% of the Homestead claims[9] and 30% of the Desert Land Act claims[10] were ever "proved up". Cattlemen and land speculators used the Desert Land Act to secure title to large tracts of land.

One of the largest privately run irrigation systems in Montana can be attributed in part to consolidation of lands claimed under the Desert Land Act. W.G. Conrad and his brothers obtained title to some 50,000 acres in the area around Conrad which became a large part of the ground now served by the Pondera County Canal and Reservoir Company (PCCRC).[11] Successors in interest to the Conrad Brothers used the provisions of the Carey Land Act to organize a large irrigation project to serve this land and other adjacent ground. Under the provisions of this act, two companies were formed in 1909. One consisted of the owners of the land within the project and the other was the construction company that was contracted to build the ditch system. The Carey Land Act Board accepted the project as complete in 1953. At the time of the final acceptance, 72,000 acres were authorized for irrigation.[12]

Irrigation in Montana generally developed on the basis of individual or small group initiatives until the turn of the century. Irrigation companies then began to form in many places to secure funding for larger projects. The federal government got involved and projects such as the Milk River Project, the Lower Yellowstone Project and the Huntley Project were all authorized by the USBR between 1903 and 1905. Once completed, these projects served approximately 200,000 acres in the Milk River and Yellowstone River Valleys.[13] The Sun River Project was the next USBR project developed in Montana with construction on the Fort Shaw Division beginning in 1907 and on the Greenfields Division in 1913. Approximately 93,000 acres are irrigated under the Sun River Project.[14]

Between 1917 and 1939, Montana recorded seventeen years of below average precipitation.[15] This led to an even greater push for federal involvement in irrigation projects. In the 1930's, USBR projects included rehabilitation of the Bitter Root Project in Ravalli County which had been originally constructed by private interests, construction of the Frenchtown Project which diverts water from the Clark Fork River west of Missoula and the Buffalo Rapids Project on the Yellowstone.[16] These three projects combined cover approximately 40,000 acres of irrigated land.

Also during the 1930s, water conservation funds became available to the states from the federal government. To take advantage of this opportunity, Montana created the State Water Conservation Board in 1933 to manage both state and federal money for small irrigation projects. Farmers who wanted to build irrigation facilities petitioned the Board and, if the proposal was accepted, the Board built the project and the farmers reimbursed the state. By 1952, the State Water Conservation Board had built 173 projects throughout the state.[17] The State, now through the Department of Natural Resources and Conservation, Water Projects Bureau, still maintains interest in and responsibility for several of these structures and systems. In most cases, ownership and responsibility for operation and maintenance have been wholly turned over to the water users. See Table 1 below for a listing of the current DNRC Irrigation Projects. This includes dams and canal systems. See Figure 4 in Section 4 of this report for a map of the location of the DNRC Irrigation Project dams and canals.

State Projects	
Dams	***Canals***
Ackley Lake Dam	Ackley Lake Supply & Outlet Canals
Bair Reservoir Dam	
Cataract Dam	
Cooney Dam & Glacier Lake Dam	Cottonwood, Finn, Point of Rocks & Pryde Canals
Cottonwood Dam	
Deadmans Basin Dam	Supply, Careless Creek & Barber Canals
East Fork of Rock Creek Dam	Main, East, Marshall, Allenedale & Metcalf Canals
Fred Burr Dam	
Frenchman Dam	
	Little Dry Canal
Martinsdale Dam	Checkerboard, North Fork Diversion, Supply, Outlet & Two Dot Canals
Middle Creek Dam (Hyalite)	Cottonwood Canal
Nevada Creek Dam	Douglas and North Canals
Nilan Dam	Nilan Reservoir Supply Canal
North Fork of Smith River Dam	
Painted Rocks Dam	
Ruby River Dam	
Tongue River Dam	
Toston Dam	Broadwater-Missouri Main, West & East Canals
Willow Creek Dam	
Yellowater Dam	

***Table 1**. State Projects, Dams and Canals.*

Throughout the 1940s, 50s and 60s, USBR and the State Water Conservation Board continued to develop new projects. Most notable are the dams and storage facilities constructed under the Pick Sloan Missouri River Basin Program. The Pick Sloan program developments were constructed to serve several purposes including flood control, hydropower generation, municipal water supply and irrigation. However, the irrigation component of this program appears to be underserved in Montana. According to Senate Joint Resolution No. 16 of the 2001 Montana Legislature, 590,000 acres of land were flooded when the Pick-Sloan projects were completed. The State was promised 1,313,930 acres of new irrigation in return. As of 2001, only 76,200 new irrigated acres had actually been developed.[18] A large irrigation project near Chester is currently being developed that would utilize water from Lake Elwell, one of the Pick-Sloan projects.

In 1981, the 47th Legislature passed House Bill 709 directing the DNRC to "…develop a strategy to protect Montana's water from downstream uses and to insure water availability for Montana's future needs…".[19] While this bill did nothing to provide funding for irrigation infrastructure, it led to the development of Montana's Water Reservation program which legally protects water for future uses in the state. This has aided in the continued development of irrigation projects by ensuring that water will be legally available for new irrigation in areas such as the Lower Missouri and the Lower Yellowstone River Basins where it is physically available. Several new irrigation projects along the Lower Missouri and Lower Yellowstone have been developed in the past three decades and more projects continue to be developed today under the protection of the Water Reservations.

3.2 Current Types of Irrigation Systems

The United States Department of Agriculture (USDA) classifies irrigation systems into four different types of distribution methods. These are; sprinkler, "gravity flow" or flood, drip or trickle (sometimes referred to as micro-systems) and subirrigation. Flood and sprinkler systems are the dominant irrigation methods in Montana. There are very few drip or trickle systems and only a small amount of acreage falls into the subirrigation category.

According to the Farm and Ranch Irrigation Survey conducted by the USDA National Agricultural Statistics Service (NASS) as part of the Census of Agriculture, in 2003, the total number of irrigated acres in Montana was estimated at 2,131,955.[20] Of this total, 64% were flood irrigated and 36% were irrigated with sprinklers. The NASS report breaks the flood and sprinkler categories down further. See the tables below for a summary of the Montana data from the 1998 and 2003 Farm and Ranch Irrigation Surveys.

	Total	Flood		Sprinkler		Drip or Trickle		Subirrigation	
	Acres	*Acres*	*% of Total*	*Acres*	*% of Total*	*Acres*	*% of Total*	*Acres*	*% of Total*
2003	2,131,955*	1,361,731	64%	773,008	36%	652	0%	3,610	0%
1998	1,740,873*	1,171,807	67%	570,550	33%	0	0%	16,325	1%

Table 2. *Land Irrigated by Method of Water Distribution 1998[21] and 2003 Farm and Ranch Irrigation Surveys, USDA NASS.*

		Flood Irrigation Field Delivery Methods							
	Total Flood	Down Rows or Furrows		Controlled Flooding (border or between rows)		Uncontrolled Flooding		Other	
	Acres	*Acres*	*% of Total*	*Acres*	*% of Total*	*Acres*	*% of Total*	*Acres*	*% of Total*
2003	1,361,731*	223,866	16%	720,752	53%	405,174	30%	11,939	1%
1998	1,171,807*	159,521	14%	336,208	29%	582,705	50%	93,373	8%

Table 3. *Land Irrigated by Flood (Gravity Flow) Systems 1998 and 2003 Farm and Ranch Irrigation Surveys, USDA NASS.*

		Sprinkler Irrigation Field Delivery Methods							
	Total Sprinkler	Center Pivot		Side roll, wheel move		Hand move		Other[&]	
	Acres	*Acres*	*% of Total*	*Acres*	*% of Total*	*Acres*	*% of Total*	*Acres*	*% of Total*
2003	773,008*	495,051	64%	196,136	25%	61,341	8%	20,480	3%
1998	570,550*	241,287	42%	231,547	41%	86,555	15%	11,161	2%

Table 4. *Land Irrigated by Sprinkler Systems 1998 and 2003 Farm and Ranch Irrigation Surveys, USDA NASS.* ([&] Other includes linear move towers, big guns or travelers and permanent systems)
(* Due to statistical sampling margin of error, individual methods acres values do not exactly match total acres values.)

Based on these survey estimates, it appears that between 1998 and 2003 there was a shift towards more sophisticated irrigation methods. While the overall difference in the percentage of acres flood irrigated versus sprinkler irrigated was small, there was a more than 20% increase in the acres under center pivots with a corresponding decrease in use of wheel lines and hand lines. The estimates for flood irrigation show a marked increase in controlled flooding methods when compared to uncontrolled flooding.

While no cause and effect relationship can be drawn from this limited information, it is possible that these differences are driven by water conservation concerns. For example, among the systems under center pivots, there was an increase in the percentage of acres under low pressure systems from 50% in 1998 to 56% in 2003 and a decrease in high pressure systems from 10% in 1998 to 3% in 2003.[22] Low pressure systems conserve water compared to high pressure systems because less water is lost to evaporation between the sprinkler heads and the crop canopy. Such changes require investment in new or modified infrastructure.

For the first time since the first Farm and Ranch Irrigation Survey was conducted in 1979, the 2003 survey found that nationwide, more acres were irrigated with sprinklers than with flood irrigation methods. However, flood irrigation still dominates in Montana and this is likely to continue for many years to come. One reason is that the major irrigated crop in Montana, when calculated based on number of irrigated acres, is hay. The cost of installing sprinkler systems for irrigation of such a low value crop cannot always be recouped in any reasonable time frame. Additionally, in many parts of the state, the topography lends itself well to gravity flow flood irrigation, eliminating the need to pay for power. However, controlled flood irrigation on large acreages can be very labor intensive. In the future, increased competition for limited water resources and/or diversification of crop types could lead to a greater increase in sprinkler irrigation.

3.3 Storage Facilities

The Montana Dams GIS spatial coverage data maintained by Montana Department of Fish, Wildlife & Parks, lists over 800 dams used for irrigation purposes.[23] The vast majority of these are small storage reservoirs owned by private individuals for their own private use. Still, the large number of storage facilities points to the importance of storing water for use later in the irrigation season. The size and relative importance of storage to irrigation varies greatly. Large facilities such as Canyon Ferry Lake and Clark Canyon Reservoir provide irrigation water to thousands of acres in addition to providing flood control, recreational opportunities and other purposes.

Different areas around the state present a variety of challenges when it comes to storage. For example, in the Bitterroot Valley, farmers long ago recognized the value of capturing the high spring flows, especially from the steep canyons of the Bitterroot Mountains. Several dams were constructed in the late 19th and early 20th century in remote locations far up the drainages. The farmers came to depend on the late season water that could be released from the reservoirs. However, the remote locations pose challenges to operation and maintenance of the structures. This is still true today, though some of the challenges are more political in nature because some of the dams are located in a designated wilderness area, placing certain restrictions on operation and maintenance activities.

In other parts of the state such as the High Line, one of the challenges is a lack of topographic relief. One of the systems chosen for a site evaluation for this study was the North Chinook Irrigation Association. This system includes a storage facility consisting mainly of large earthen dikes that have been built up on a large area of flat ground. When the shallow reservoir is full of water, it creates a very large surface area and on hot windy days, the level in the reservoir can drop rapidly.[24] See Figure 1 below for a map depicting the locations of irrigation dams across the state.

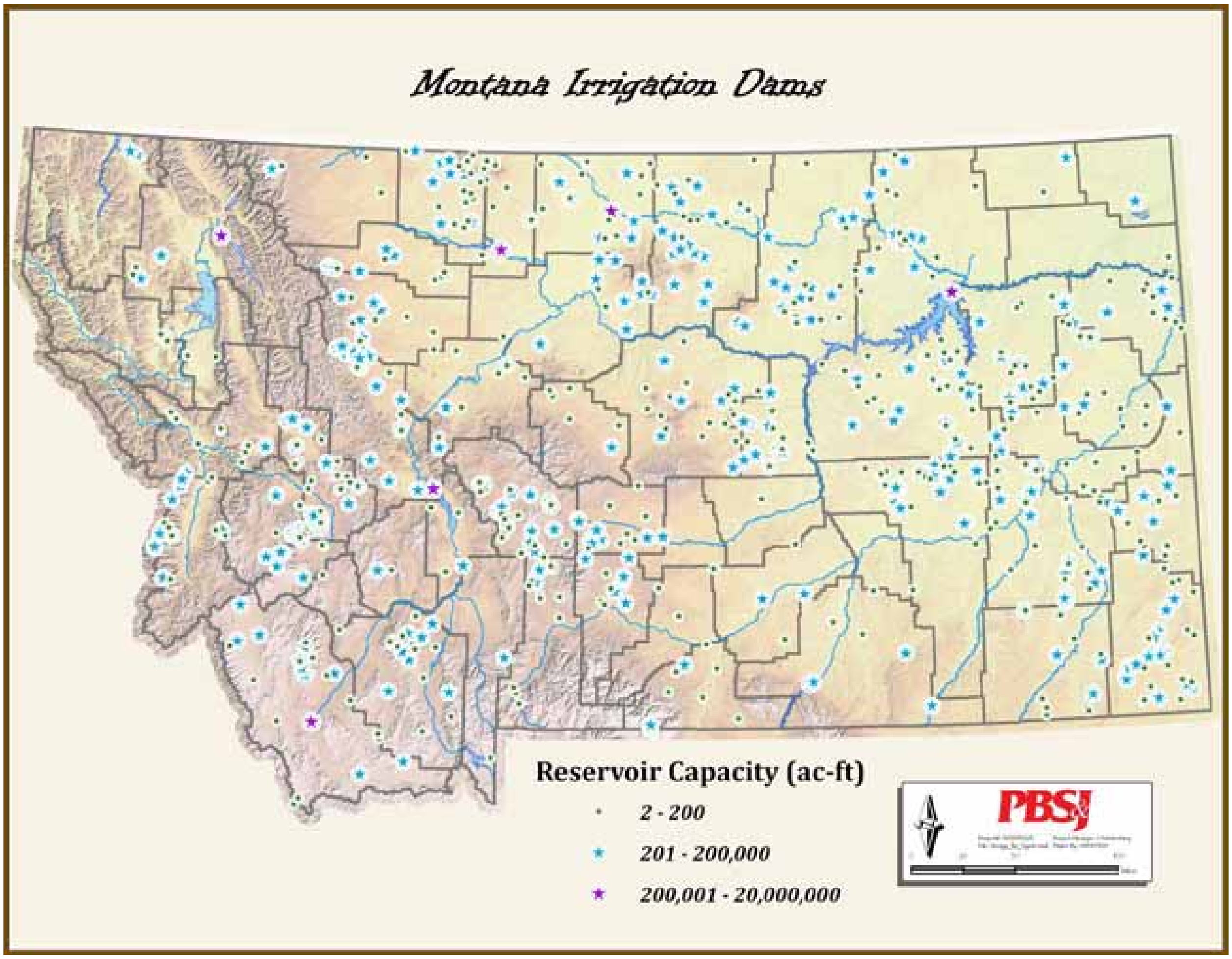


***Figure 1**. Montana Dams According to Montana Fish, Wildlife & Parks GIS Data.*

3.4 Types of Users

3.4.1 Irrigation Organizations (Districts, Companies, Water User Associations, etc.)

The 2003 Farm and Ranch Survey estimates that 1.2 million acres were irrigated exclusively with water referred to as "off-farm" water which is water controlled by some type of water supply organization such as an irrigation district, the USBR or a private ditch company.[25] An additional 100,000 acres were reported as using some off-farm water. Based on these figures, approximately 60% of the irrigated acres in Montana get some or all of their water from some type of water supply organization.

Generally, with USBR and State projects, the agency maintains some responsibility for the infrastructure but the day to day operations of the systems are left up to irrigation districts or water user associations.[26] In the case of very large projects such as the Milk River project, multiple irrigation districts were formed to cover different geographic areas and different branches of the canal system. Other types of water user organizations have formed all across the state for various reasons. Following is a brief description of the types of organizations.

Irrigation Districts are quasi-governmental agencies that are authorized by the District Courts. Title 85, Chapter 7, MCA regulates the formation and operation of irrigation districts. Irrigation Districts have been formed in association with all of the USBR irrigation projects in Montana. Listed in Table 5 below are the 17 USBR Irrigation Districts. For a map of the location of these facilities, please see Figure 3 in Section 4 of this report. These districts all operate facilities that were constructed or reconstructed by the USBR who maintains some level of involvement with the irrigation facilities.

District Name	County
East Bench Irrigation District	Beaverhead
Paradise Valley Irrigation District	Blaine
Toston Irrigation District	Broadwater
Intake Irrigation District	Dawson
Savage Irrigation District	Dawson
Fort Shaw Irrigation District	Lewis and Clark
Helena Valley Irrigation District	Lewis and Clark
Big Flat Irrigation District	Missoula
Frenchtown Irrigation District	Missoula
Dodson Irrigation District	Phillips
Malta Irrigation District	Phillips
Buffalo Rapids Irrigation District	Prairie
Bitter Root Irrigation District	Ravalli
Lower Yellowstone Irrigation District	Richland
Greenfields Irrigation District	Teton
Glasgow Irrigation District	Valley
Huntley Project Irrigation District	Yellowstone

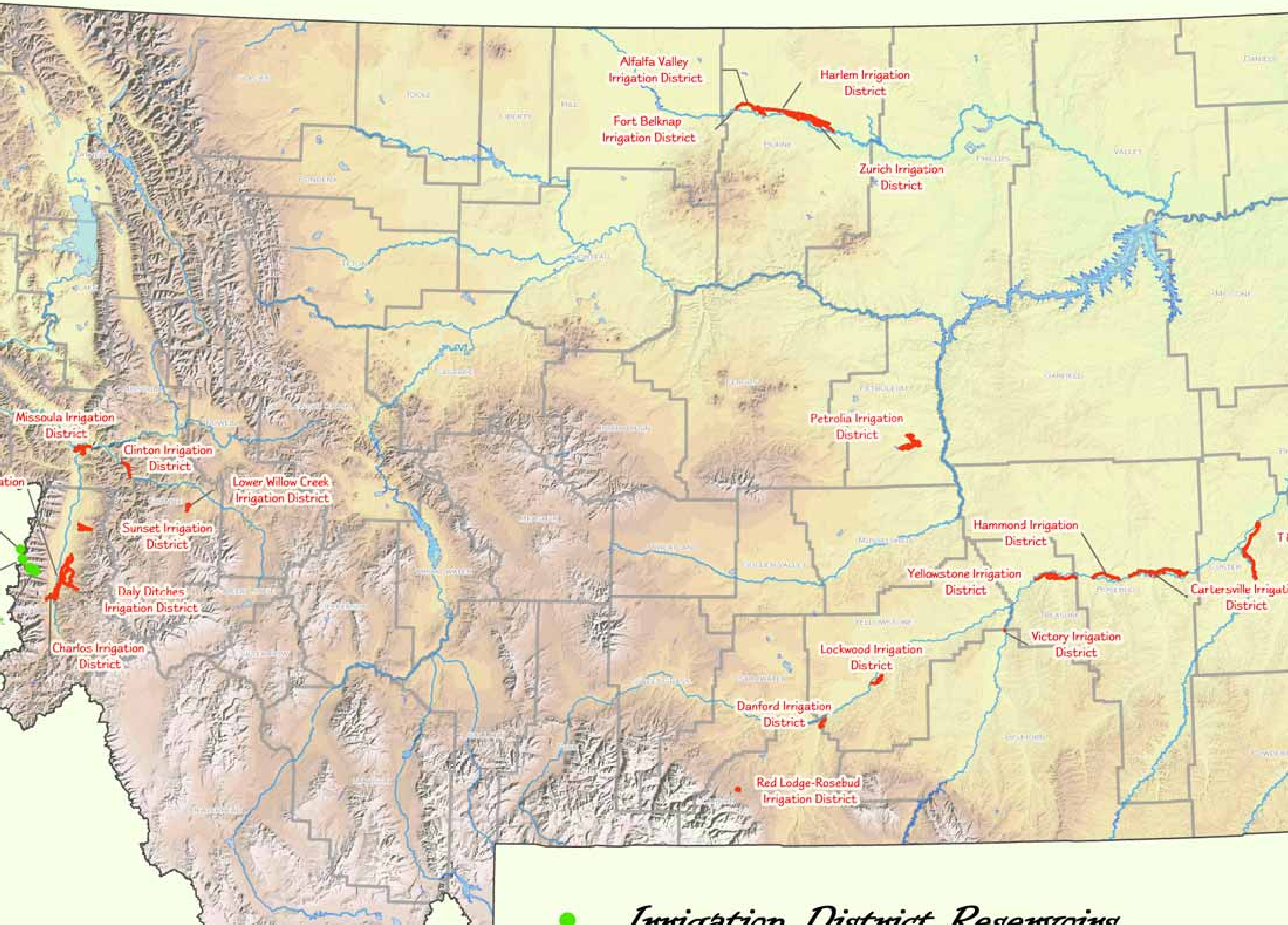
Table 5*. Irrigation Districts Associated with US Bureau of Reclamation Irrigation Projects.*

Many irrigation districts have formed that are not associated with USBR facilities. Twenty-six districts in addition to those listed above were identified during this study. These districts range greatly in size from a few hundred acres for groups like the Glen Lake and Lomo Irrigation Districts to around 10,000 acres for the Cartersville and Yellowstone Irrigation Districts. Table 6 below lists all of the irrigation districts not associated with the USBR that were identified during this project. Figure 2 is a map depicting the general location of these irrigation district facilities.

District Name	County
Victory Irrigation District	Big Horn
Alfalfa Valley Irrigation District	Blaine
Fort Belknap Irrigation District	Blaine
Harlem Irrigation District	Blaine
Zurich Irrigation District	Blaine
Danford Irrigation District	Carbon
Red Lodge-Rosebud Irrigation District	Carbon
Tongue & Yellowstone River Irrigation District	Custer
Lower Willow Creek Irrigation District	Granite
Glen Lake Irrigation District	Lincoln
Clinton Irrigation District	Missoula
Missoula Irrigation District	Missoula
Petrolia Irrigation District	Petroleum
Canyon Creek Irrigation District	Ravalli
Charlos Irrigation District	Ravalli
Daly Ditches Irrigation District	Ravalli
Lomo Irrigation District	Ravalli
Mill Creek Irrigation District	Ravalli
Sunset Irrigation District	Ravalli
Ward Irrigation District	Ravalli
Sidney Water Users Irrigation District	Richland
Cartersville Irrigation District	Rosebud
Hammond Irrigation District	Rosebud
Blodgett Creek Irrigation District	Teton
Yellowstone Irrigation District	Treasure
Lockwood Irrigation District	Yellowstone

Table 6. *Irrigation Districts not Associated with the USBR.*

District Main Structures



Regardless of whether or not the USBR is involved, land owners in an irrigation district are assessed a fee for water on their tax bills. In areas where subdivision or other land use changes have eliminated a land owner's access to the ditch, he or she is typically still required to pay the assessment. In urban and suburban areas, this is a growing issue for many people who pay the fee but receive no benefit from it. District Court approval is required if an irrigation district desires to change its boundaries to include or exclude property.

Water user associations are another common type of water supply organization. Such associations have been created for most of the DNRC State Water Projects (SWP) systems. SWP water users associations typically handle operation of the systems on a daily basis, releasing water from the dams as it is needed by the water users, for example. However, the DNRC maintains ownership of these facilities. The water users and the DNRC share the burden of costs associated with major repairs.

Some DNRC SWP projects include both storage facilities and delivery canals and others involve only the storage facility. The Flint Creek project for example, includes the East Fork Reservoir Dam as well as the Flint Creek, Allendale, East, Marshall and Metcalf ditches. However, for projects such as the Painted Rocks project on the West Fork of the Bitterroot River, the State only owns the dam and the water is delivered to privately owned headgates and ditches which are solely the responsibility of the ditch users. Typically, water user associations connected to State Water Projects have contracts or long term leases with the State specifying a price per acre-foot (ac-ft) of water delivered from the project.

Other groups of water users have formed associations that are variously called water user associations, irrigation associations, ditch or canal user associations, etc. The degree to which these organizations have legally formalized their arrangements varies. Some very large systems fall into this category such as the Billings Bench Water Association. There are also smaller systems that may only encompass a few users on a small ditch.

Most water supply organizations are legally incorporated entities and refer to themselves as ditch or canal "companies". In the Gallatin Valley for example, there were as many as fifteen different ditch companies operating at the time the Water Resources Survey (WRS) was conducted in the early 1950s. Most of them are still in operation today. In 1953, these companies accounted for approximately 60% of the irrigated land in the Gallatin Valley whereas about 40% was served solely by privately owned ditches. Subdivision and development around Bozeman has changed the land use patterns in the valley, but the ditch companies are still active. The companies have even banded together to form the Association of Gallatin Agricultural Irrigators (AGAI) to advocate for their rights in the face of competing interests.

Water supply organizations benefit their users by allowing the cost of operation and maintenance to be shared among multiple (sometimes hundreds of) users. They also supply the users with a means to communicate with each other and/or the organizations' supervisors, which is a critical aspect of irrigation and one that is often overlooked. When disputes arise, it is helpful if there is a means for people to easily contact each other. When no such means exists, water users often turn to agencies such as the DNRC or the Conservation District for assistance. Aside from water rights management, the State of Montana has no authority over irrigation system operations, especially private systems. As a result, agency personnel often have little first hand knowledge of the operation of private systems.

3.4.2 Private Water Users

Based on the Farm and Ranch survey, 40% of the State's irrigated acres are served by privately owned systems. This survey includes both groundwater and surface water sources. In the case of irrigation from groundwater wells, the irrigator typically has control of both the location where the water is withdrawn as well as the location where the water is used. This is often not the case for surface water. Many private ditches tap their source a long distance from the fields they serve and can cross multiple property lines. This often raises issues about operation and maintenance. Communication about these issues can be more difficult when there is no centralized organization in charge. This can, and often does, lead to costly litigation.

The Musselshell River is an example of a location where there are more private users than water supply organizations. Conflicts over water availability and water rights in this drainage led the Montana Water Court, with assistance from the DNRC, to spend a great deal of effort establishing an enforceable Water Court decree on the Musselshell River. The Musselshell is the largest reach of river in Montana that has such an enforceable decree.

For the purposes of this study, we did not make an effort to contact private water users. The sheer number of individual irrigators put this option beyond the scope of the project. Future investigations could consider an assessment of private irrigation systems.

4.0 Summary of Existing Information

4.1 Introduction

As part of the overall Inventory of Irrigation Infrastructure, existing data was gathered from state and federal agencies. Reports were gathered from the United States Bureau of Reclamation (USBR), the United State government Accountability Office and the Montana Department of Natural Resource and Conservation (DNRC). An attempt was made to obtain information from the United States Bureau of Indian Affairs, however, our request was not honored. Following is a summary of the information that was gathered.

4.2 United States Bureau of Reclamation Irrigation Projects

The United States Bureau of Reclamation (USBR) has thirteen irrigation projects in Montana that serve approximately 365,500 acres. Table 7 lists all of the projects and the approximate number of acres served by each one. Figure 3 is a map depicting the location of the major components of these projects

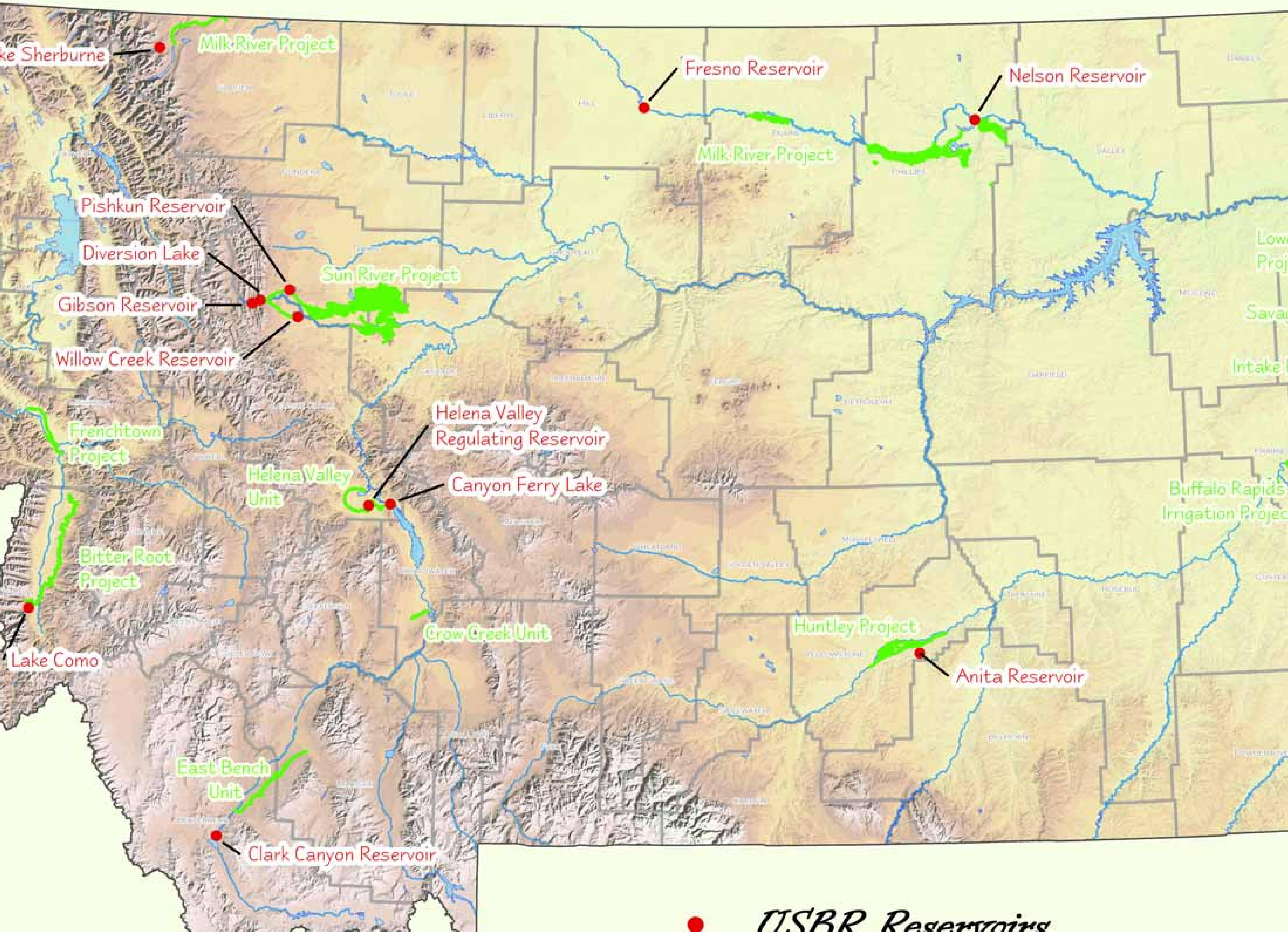
Project or Program	Division or Unit	Acres
Bitter Root Project		16,700
Buffalo Rapids Project	First Division (Glendive Unit)	16,300
	Second Division (Shirley, Terry & Fallon Units)	11,380
Frenchtown Project		5,000
Huntley Project		35,000
Intake Project		820
Lower Yellowstone Project		55,000
Milk River Project	Paradise Valley	8,300
	Dodson Pumping Unit	1,150
	Glasgow Division	18,000
	Malta Division	42,000
Missoula Valley Project	Big Flat Unit	1,000
Pick-Sloan Missouri River Basin Program	Crow Creek Unit	6,500
	East Bench Unit	30,000
	Helena Valley Unit	22,000
	Savage Unit	2,200
Sun River Project	Fort Shaw Division	10,150
	Greenfields Division	81,000
	Total Acres	**365,500**

Table 7. *USBR Irrigation Projects in Montana and Approximate Number of Acres Irrigated by Each Facility.*

The USBR conducts periodic examinations of each facility and documents the findings in Associated Facility Review Examinations Reports. The reports contain recommendations from USBR staff and photographic documentation of selected components of each facility.

The recommendations fall in to three categories. Category 1 recommendations address severe deficiencies involving structural safety, operational integrity and facility personnel and/or public safety. Category 2 recommendations address actions that need to be taken to prevent or reduce further damage, preclude the possibility of operational failure and/or reduce safety risks for facility personnel and the public. Category 3 recommendations include suggestions to improve or enhance the operation and maintenance of the facility.

Irrigation Project Main Structures in Montana



Following is a brief description of each project and the condition of the facilities based on the most recent Associated Facility Review Examinations that were supplied to PBS&J by the USBR.

4.2.1 Bitter Root Project

The Bitter Root Project provides irrigation water for approximately 16,700 acres mainly on the east side of the Bitterroot River in Ravalli County, MT. The infrastructure associated with this project was originally constructed by private interests. In the 1930's, USBR was authorized to rehabilitate the irrigation system. The main components of the system are; Como Dam and Lake Como on Rock Creek, a diversion dam on Rock Creek, a feeder canal from Lost Horse Creek and the main Bitter Root Irrigation District Canal. Como Dam was completed in 1910.

The USBR and the Bitter Root Irrigation District (BRID) performed major repairs on the dam in 1954 and 1976. In the early 1990's, the State of Montana provided funding for major modifications to the dam to mitigate potential for damage due to seismic events or major floods. These modifications increased the storage capacity of the dam. The District and the State agreed that in exchange for funding the repair work on the dam, the State would be entitled to use the added storage water, 3,000 acre-feet (ac-ft) to benefit instream flows.

The diversion dam on Rock Creek is a 10.5 foot high rock-fill structure. The main canal has an initial capacity of 325 cubic feet per second (cfs) and is 60 miles long. Extensive rehabilitation of the main canal and its major components was conducted in the mid-1960's and in 1974. Siphon No. 1 required major repairs after floodwaters damaged the siphon where it crosses the Bitterroot River. Over the past ten years, BRID has made some minor improvements to the diversion structure and has received federal funding to assist with the cost of lining sections of the canal.

In the late 1990's and early 2000's, BRID began an effort to collect extensive data about their entire system and compile it into a geographic information systems database. This effort is still on-going. A list of structures and their conditions has been developed. This has helped the District focus on areas most in need of repair. Siphon No. 1 is the most crucial problem on the system. A preliminary engineering report estimates that this structure needs to be replaced and that it will cost over $6 million. Other problem areas include ten or more bridge crossings over the canal that are in poor condition, wooden flumes that in the past carried water over the ditch that are no longer functioning and at least one stream crossing structure that is deteriorating.

The BRID system is aging. Construction of the original infrastructure began 100 years ago. While rehabilitation efforts have maintained the overall viability of the system, some major components are in need of replacement and many minor components need an extensive amount of work.

4.2.2 The Buffalo Rapids Project

The Buffalo Rapids Project provides irrigation water for over 27,000 acres in Prairie and Dawson Counties, in the vicinity of Glendive, Fallon, and Terry, Montana. Five pumping plants pump water directly from the Yellowstone into project canals. All the pumps are electric and are supplied with power from the Pick-Sloan Missouri Basin Program. Construction of the first pumping plant at Glendive began in 1937. The fourth plant was completed in 1948 and the last plant, Glendive No. 2, was constructed in 1978.

The project includes two divisions. The First Division includes the Glendive Unit. It is managed by Buffalo Rapids Irrigation District No. 1 and is served by Glendive Pumping Plant Nos. 1 and 2. The Second Division includes the Shirley, Terry, and Fallon Units. It is managed by Buffalo Rapids Irrigation District No. 2 and is served by the Shirley, Terry and Fallon Pumping Plants, and by the Fallon Relift pump. Each unit has a separate canal and lateral system with a total of 62 miles of main canal and approximately 96 miles of laterals.

This project, with its reliance on pumps instead of gravity flow, presents some different maintenance challenges. The Districts have a strict schedule of maintenance and inspection of pump and motor components. This includes a maintenance cycle of five-years on all motors and three-years on all pumps. All pump motors except those in the Fallon pumping plant have been replaced since the early 1990's. The most recent replacements were at Glendive No. 1 which were done within the last four years.

Safety is a big concern at the pumping plants since staff must work around large machinery with high voltage electrical systems. Cranes have been installed in most of the pumping plants to replace chain hoists. This is both a labor saving measure and a safety improvement.

Over the past nine or ten years, the Districts have invested time and money into replacing open ditch laterals with pipeline. These efforts have been assisted by a 75% grant from the Natural Resources Conservation Service (NRCS) Environmental Quality Incentives Program (EQIP). While this investment has caused District No. 1's financial reserves to dip below levels recommended by the USBR, the District Manager estimates the pipeline installation will save more than $100,000 per year in operation and maintenance (O & M) costs. With savings of that magnitude, it should be possible to bring the financial reserves back up to appropriate levels.

The most recent examination of this project was conducted by the USBR in October 2007. USBR personnel concluded that the general condition of the project and the condition of the main canals were very good. There were no Category 1 recommendations. There were twneyty-three Category 2 recommendations, 7 of which were items that had been identified during the previous exanimation. Finally, there were three Category 3 recommendations.

Most of the recommendations are related to infrastructure issues and include:

- Replacement of the intake structure at Fallon re-lift plant;
- Repair of the concrete on the aprons of the first and second siphons west of Cracker Box;
- Repair, replacement or removal of problematic bridges across the canal;
- Need to institute safety measures to cover holes in pumping plant floors created when equipment is removed for inspection/repair;
- Minor maintenance inside pumping plants such as replacing breaker box panels, cleaning service station transformers and protecting loose wiring with conduit.

4.2.3 The Frenchtown Project

The Frenchtown Project provides irrigation water for approximately 5,000 acres on the north and east side of the Clark Fork River beginning a few miles northwest of Missoula and extending out to Huson, MT. The diversion dam for the system is located on a side channel of the Clark Fork River. The main canal has an initial capacity of 170 cfs. Construction of the diversion dam and the main canal began in 1936 and both were complete in time for the irrigation season in 1937. Management of the project was turned over to the Frenchtown Irrigation District in December 1938.

The main canal extends for approximately seventeen miles. Laterals distribute water to the project lands, most of which are sprinkler irrigated. Heavy residential development has occurred within the project area in recent years. Very few full-time farms still exist. This presents many challenges such as an increase in the number of road crossings which can lead to the additional construction of structures that require maintenance and inspection. Other problems such as ditch leaks can cause conflicts with adjacent homeowners. Subdivision of property often interferes with ditch access. This leads to conflicts over payment of assessments for water that cannot physically reach the land that is being assessed.

According to John Moody at the USBR Ephrata Field Office, this project presents something of a dilemma for the agency. The original project intent of irrigating agricultural land has become largely obsolete. However, the value of the water, water rights and infrastructure cannot be dismissed.

4.2.4 The Huntley Project

The Huntley Project provides irrigation water for approximately 29,000 acres in south-central Montana. The diversion dam is located on the Yellowstone River approximately ten miles downstream from Billings and serves land on the south side of the river. The Project works include a rockfill and concrete diversion dam in the Yellowstone River, 54 miles of canal, 202 miles of laterals, a hydraulic turbine-driven pumping plant, an auxiliary electric pumping plant, and Anita Reservoir, an off-stream storage facility. The project is managed by the Huntley Project Irrigation District.

The Huntley Project is one of the oldest projects constructed by USBR. Construction began in 1905 and was considered complete in 1915. Additional modifications have been made to the system since that time. The capacity of the High Line Canal was significantly increased in 1917. A diversion dam was constructed in the river in 1934 to increase the overall capacity of the system and Anita Dam and Reservoir were built in 1937.

The examination performed by the USBR in 2007 revealed some major issues. Although no Category 1 recommendations were identified, the age of the system was apparent. The condition of the system and several of the Category 2 recommendations are described below.

Major repairs and modifications to the diversion dam were completed in 1999. The structure is in good condition and operating well. There is a significant amount of concrete deterioration on the main headgate at and below the water level. The structure is still functioning but repairs are needed. There are three tunnels on the main canal. The concrete at the entrance to Tunnel No. 1 is deteriorating in a few locations. Although these areas are not large, repairs are needed to prevent further damage. Tunnel No. 1 also has two sections of cracked concrete through which water is leaking and two areas where debris collects inside the tunnel.

Tunnel No. 2 has some serious issues. There is a depression in the ground surface above the tunnel that seems to be increasing in size. There is a corresponding hole in the crown of the tunnel approximately forty-two feet in length. Additionally, there is a hole in the wall of the tunnel just above the dewatered level that will continue to grow if it is not repaired. Tunnel No. 3 is in good condition. Other problematic structures on the main canal include erosion around the Leroy Gable drain culvert that goes under the canal and concrete deterioration on the Arrow Creek cross drain.

The mechanical parts of the Ballantine Pumping Plant are well maintained and seem to be in good condition. However, four large cracks in the walls of the building are cause for concern. It is not known if the cracks are getting larger or not. The USBR recommends that the District take measures to monitor the cracks for movement. It was also recommended that the interior of the pumping plant conduits be inspected with a remote camera, as there was no record of when such an inspection was last performed.

The siphon from Anita Reservoir to the High Line Extension Canal is leaking on some areas and the weir into the Reservoir Line Canal is not in useable condition. Anita Dam and Reservoir were not inspected as part of this examination but will be inspected as part of a reclassification process for this facility. In general, this system is in fair condition especially considering the fact that the main part is 100 years old. The District has done a good job of prioritizing maintenance issues and addressing problems before they become severe.

4.2.5 Lower Yellowstone Project (including the Intake Project and the Savage Unit)

The Lower Yellowstone project provides irrigation water for approximately 55,000 acres in east-central Montana and western North Dakota. About two-thirds of this area is in Montana. The Montana portion is referred to as District No.1 and the North Dakota portion is District No. 2. The Intake Project and the Savage Unit of the Pick-Sloan Missouri River Basin Program (PSMRB Program) pump water out of the Lower Yellowstone Main Canal. Intake serves approximately 830 acres and Savage serves almost 2,200 acres. The Lower Yellowstone Board of Control manages all four of these systems but each is operated by its own irrigation district.

The project extends from its Yellowstone diversion dam located just south of Intake, MT down the west side of the Yellowstone River valley through Richland County, MT, and on into North Dakota to the confluence of the Yellowstone and the Missouri Rivers. The diversion dam is a 700-foot rock-filled crib dam that spans the width of the river. The structure was damaged early on in the project's history, so now rock must be added periodically. The District has set up two towers, one on each side of the river channel, linked with a cable system that is used to add rock to the dam.

The existing headworks have eleven 5 ft x 5 ft sluice gates and an initial capacity of 1,400 cfs. The headworks structure and diversion dam have been the subject of much scrutiny over the past several years due to evidence of impacts on the endangered pallid sturgeon. Pallid sturgeon and other fish species are entrained in the canal through the headgate structure and there is evidence that the diversion dam may be a barrier to upstream migration of the pallid sturgeon. Preliminary design reports from the Army Corps of Engineers (ACOE) estimate the cost of an adequate structure to prevent entrainment to be over $19 million. Various alternatives for providing passage over the dam range in estimated cost from $11 million to over $43 million. While these costs are not directly related to the condition of the irrigation system infrastructure, they represent costs necessary to operate the irrigation system in compliance with the Endangered Species Act.

The Intake Irrigation District Pumping Plant is located on the Main Canal about 1.5 miles downstream of Intake, MT. Construction began in 1945 and was completed in 1946. Intake was authorized under the 1939 Water Conservation and Utilization Act as well as under the terms of the Pick-Sloan Program; however, because construction proceeded under the earlier authorization this project, unlike others constructed during this time period, is not considered part of the PSMRB Program.

There are two pumps in the facility. One supplies Lateral A3 and produces 15 cfs while the other supplies Lateral A2 with 3 cfs. The 2007 USBR examination of this facility generated no new recommendations. The only recommendation that was incomplete from the previous inspection in 2001 was to replace the “Danger High Voltage” sign at the entrance to the plant. The District adheres to an extensive maintenance program for the motors and pumps to ensure uninterrupted operation.

The Savage Irrigation District Pumping Plant feeder canal takes out of the Lower Yellowstone Main Canal approximately thirteen miles downstream from the headworks. The feeder canal runs about 100 ft to the pumping plant. The Savage Unit is part of the PSMRB Program. Construction of the project began in 1949 and water was available for the 1950 irrigation season.

The Savage Pumping Plant contains two motor-driven 250-hp pumps, each discharging 21 cfs. Power to operate the pumps is supplied under the terms of the PSMRB Program. The 2007 USBR examination of this facility generated no new infrastructure related recommendations. One outstanding recommendation from the 2001 inspection was incomplete. This involved establishment of a center-line benchmark for the discharge conduit. The benchmark was recommended so that the District could be sure to keep vegetation clear from within twenty feet of the center-line. The Savage Pumping Plant is on the same extensive pump and motor maintenance and inspection program as the Intake and Lower Yellowstone Districts. The system is in good condition.

Down the canal from the Savage Plant, are two pumping plants on the Main Canal, Thomas Point and Crane, and one on Drain 27. The Thomas Point Pumping Plant is about nineteen miles below the headworks. The plant has two units directly connected to hydraulic turbines and one motor-driven unit. The energy derived from 80 cfs of water falling twenty-eight feet from the Main Canal to Lateral KK is utilized by the two hydraulic turbine driven pumps to lift 45 cfs up 31 feet to Lateral LL. The motor driven unit pumps 20 cfs from the Main Canal into Lateral LL.

The Crane Pumping Plant has two motor-driven units, each of which pumps 5 cfs from the Main Canal into Lateral BP-1. The pumping plant at Drain 27 has one motor-driven unit which pumps 15 cfs of water from the drain into Lateral N. The Lower Yellowstone Irrigation District pumping plants are all in good condition. An extensive maintenance program keeps the pumps and motors in good working order and alerts District personnel to any potential problems before they become severe.

The Lower Yellowstone Main Canal is over 71 miles long. The 2007 USBR examination did find some issues that need to be addressed however, the system is in good condition overall. There were two incomplete Category 2 recommendations from the 2001 examination, two new infrastructure related Category 2 recommendations and one Category 3 recommendation. The incomplete recommendations from 2001 were to inspect the downstream side of the Main Canal headworks structure and to add a check to the downstream culvert at the Lateral M pump to maintain adequate water levels.

The new recommendations included major repairs on the Burns Creek Wasteway that is badly deteriorated and removal or repair of a footbridge across the canal near Savage. This bridge is in very poor condition and is in imminent danger of falling into the canal. The Category 3 recommendation was to replace some metal wires on one pipeline with stainless steel in order to prevent further corrosion.

The Lower Yellowstone Project covers a large area and the original structures are over 100 years old. It is in good condition especially when its size and age are considered. This is most likely attributable to the project's emphasis on regular maintenance and inspection programs. The average annual O&M expenditures over the last five years have been approximately $1.2 million and at the time of the 2007 examination, the District had financial reserves of 112% of the 2006 expenditures.

4.2.6 The Milk River Project

The Milk River Project in north-central Montana furnishes water for the irrigation of about 121,000 acres of land. The Project's main features are Lake Sherburne; Nelson and Fresno Storage Dams; Dodson, Vandalia, St. Mary, Paradise, and Swiftcurrent Diversion Dams; Dodson Pumping Plant; 200 miles of canals; 219 miles of laterals; and 295 miles of drains. The project includes three divisions, Chinook, Malta, and Glasgow and the Dodson Pumping Unit. The irrigated land extends about 165 miles along the river from near Havre to a point six miles below Nashua, MT.

Water for the Milk River Project is first diverted from Swiftcurrent Creek by impounding water behind Lake Sherburne Dam. Stored water is released down Swift Current Creek into St Mary's Lake and from there it flows down to the St Mary's Diversion Dam where stored water and free-flow St Mary's River water are diverted into the 29-mile long St Mary's Canal. The St Mary's Canal discharges into the North Fork of the Milk River approximately twentymiles northeast of Babb, MT. The North Fork of the Milk River then flows into southern Alberta and on into southern Saskatchewan before returning to Montana in north-central Hill County.

The Milk River Project is historic in that it was one of the first Bureau of Reclamation projects authorized by the federal government. It was authorized in 1903 and construction began in 1906. The first water was delivered for irrigation in 1911. This system is sometimes referred to as the "Lifeline of the Hi-line" because it is so critical to water availability for many uses in the Milk River drainage. The project has been the subject of much scrutiny for the past several years due to the severe deterioration of major components of the system and inadequate funding available for repairs and reconstruction. The St Mary's diversion and canal system is one portion of the project that needs significant work; however, there are also several additional major issues with the irrigation systems on the Milk River.

4.2.6.1 St. Mary's Diversion and Canal

The issues begin with the Lake Sherburne Dam. The current outlet structure is unable to pass low flows during the winter months. As a result, Swiftcurrent Creek dries up and what is believed to be important wintering habitat for the threatened bull trout is lost.

USBR estimates that it will cost approximately $900,000 to fix this problem. Another issue that is important though not directly related to the functioning of the system for irrigation purposes is sedimentation in Lower St. Mary Lake. When this project was constructed, a dike was built to route the flow of Swiftcurrent Creek into the lake. A delta has formed and appears to be growing. It is estimated that the size of the delta increased by sixteen acres between 1958 and 1990. USBR estimates that it will cost approximately $598,000 to address this issue.

The St. Mary's diversion dam and headworks are badly deteriorated. According to estimates provided by TD&H in a 2006 feasibility report, the cost to replace these structures is approximately $17 million. Three siphons along the St. Mary Canal are all in poor condition. Cost estimate ranges for replacing these structures are listed in the table below. The ranges represent cost estimates for various alternatives that have been investigated.

Siphon Name	Estimated Cost to Repair (in millions)
Kennedy Creek	$1.1 - $2.4
St Mary River	$27 - $37
Halls Coulee	$12 - $24

Table 8. *Estimated Cost Ranges for St. Mary's Canal Siphon Replacements.*

The canal is generally in poor condition. As part of the studies done by USBR and TD&H, cost estimates were made for reshaping and repairing the canal in its existing right-of-way and for realigning the canal and making significant improvements such as armoring and installing controlled inlets for engineered wetlands. The cost estimates for the various alternatives range from $65 to $70.1 million. Five drop structures near the end of the canal all need major repairs or replacement. It is estimated that this work will cost between $10.4 and $11.7 million. This includes rehabilitation of the canal stretches located in between the drop structures.

The total cost estimate for just the projects mentioned above range from $134 to $164 million.

4.2.6.2 The Chinook Division

The Chinook Division of the Milk River Project includes the Fort Belknap, Zurich, Harlem, Paradise Valley, and Alfalfa Valley Irrigation Districts. Only the Paradise Valley Irrigation District (PVID) operates any USBR facilities. The USBR reconstructed the Paradise Diversion Dam after it was destroyed by floods in 1965. The other four districts are part of the Milk River Project in that they receive Project water; however, none of their facilities were constructed by the USBR.

The Paradise Valley Irrigation District (PVID) provides irrigation water for approximately 8,300 acres. The Paradise Diversion Dam is located southeast of Chinook. According the 2004 USBR examination, the dam on the Milk River was in satisfactory condition. The operation of the dam requires placement of flashboards, which is a difficult job. A cableway was installed to facilitate the completion of this task but it has not operated as intended. The USBR examiners suggest that installation of an inflatable gate system would reduce the difficulty of controlling the flow over the spillway and would improve safety conditions.

4.2.6.3 The Malta Division

The Malta Division of the Milk River Project includes the Malta and Dodson Irrigation Districts. The districts together supply irrigation water to approximately 42,000 acres. The Dodson Diversion Dam diverts water from the Milk River about five miles West of Dodson, MT. The Dodson North Canal and Dodson South Canal are both served by this diversion dam. The Dodson North Canal has an initial capacity of 200 cfs and the Dodson South Canal has an initial capacity of 500 cfs. In addition to supplying irrigation district lands on the south side of the river, the Dodson South Canal delivers water to Nelson Reservoir.

The Dodson Diversion Dam underwent a major rehabilitation project in 2003. The crest gates were replaced with an inflatable gate system. Other work included replacement of the sluiceway gates, concrete repair to several components and installation of fencing and other safety measures to improve conditions around the dam. During the 2006 USBR examination, it was noted that the North Canal headworks were in satisfactory condition. There was an outstanding recommendation from the 2000 examination to repair or replace the siphon at Station 525+00. This is not complete and the District has not determined what action to take at this site.

A significant amount of work has been done in the past eight years on the Dodson South Canal. Gate position sensors and stem motors have been installed to simplify gate operation, the Point of Rocks check structure has been completely replaced and nine other check structures have been repaired/replaced under a grant from the DNRC. Removal of vegetation, especially large trees seems to be an issue on this canal. Over the past three years, the District has removed trees along the canal from Malta to Mud Lake. Trees and brush need to be removed from the Lake Bowdoin inlet and it needs concrete repair.

The Dodson Irrigation District diverts water out of the Dodson North Canal. An inlet channel brings conveys water to the Dodson Pumping Plant where it is pumped into the Dodson Pump Canal. The pump canal is about 7.5 miles long and has a capacity of 30 cfs. All of the Dodson Irrigation District facilities appeared to be in good condition. Regular maintenance of the pump motors keeps them in good working order.

The rehabilitation of the Dodson Diversion Dam and all the other infrastructure repairs that have been accomplished in recent years have greatly improved the operation of the Malta Division system. Although a few components are still in poor condition and efforts to control vegetation need to be continued, the system is functioning well.

4.2.6.4 The Glasgow Division

The Glasgow Irrigation District diverts water form the Milk River via the Vandalia Diversion Dam, about three miles west of Vandalia, MT. The District supplies irrigation water to approximately 18,000 acres. The concrete on the diversion dam is deteriorating in several places. The District has been making repairs over the past several years with funds from the State but as of the 2007 USBR examination, more work was still needed.

The 2007 USBR examination identified several outstanding issues remaining from the previous inspection in 2001. Concrete repair is still needed at the box culverts on the Vandalia South Canal where it passes under the railroad tracks and at the railroad crossing at Tampico. Safety issues that were previously noted had not been resolved and removal of woody vegetation in several key locations was not completed. New recommendations included repairs on the Antelope Creek and V114 siphons, replacing handrails in two locations and completing repairs on the main canal at the Antelope Creek Crossing where it was damaged by a storm run-off.

The District keeps very accurate records of allotments making it one of the most efficient Districts on the Milk River project. However, it struggles with a lack of funding and personnel to perform the necessary level of maintenance.

4.2.7 The Missoula Valley Project

The Big Flat Unit of the Missoula Valley Project originally provided irrigation water for approximately 1,000 acres in Missoula County. The main canal inlet is located on the Bitterroot River approximately five miles southwest of downtown Missoula. The Project works include 9.3 miles of main canal and two miles of lateral. Most of the land in the area has been subdivided. The project is managed by the Big Flat Irrigation District.

Construction of the Big Flat Unit began in 1945 and was completed in 1949. The District has had problems with deposition of sediment in the inlet channel of the main canal which they resolve by dredging and selling the material to developers or road builders. Vegetation has also been a problem. The District encourages livestock grazing as a means to control vegetation on the ditch banks. Cattle crossings have been provided however, the cattle still cross the canal in other locations causing damage.

The main canal passes through a US Forest Service (USFS) refuge. The USFS has resisted the District's request to remove woody vegetation along this stretch. This continues to be a problem for the District. Additionally, several ditch crossings have been constructed to obtain access for housing developments without the District's knowledge or approval. Such crossings cause significant problems for the District. In spite of these problems, the project structures are in fair to good condition and continue to operate adequately.

4.2.8 The Pick-Sloan Missouri River Basin Program

Several irrigation projects were constructed in Montana under the Pick-Sloan legislation. Four of these are currently used mainly for irrigation water supply. These are; the Crow Creek Unit, the East Bench Unit, the Helena Valley Unit and the Savage Unit. The Savage Unit was discussed above in conjunction with the Lower Yellowstone Project. Following is a description of the remaining three.

4.2.8.1 Crow Creek Unit

The Crow Creek Pump Unit supplies water to approximately 6,500 acres near Toston, MT. Features include Crow Creek Pumping Plant, the Toston Tunnel, Toston Canal, Lombard Pipeline, and the lateral and drainage systems. The Unit is managed by the Toston Irrigation District.

The pumping plant is located on the west bank of the Missouri River about six miles upstream of Toston. The plant contains three units each capable of producing 33.3 cfs with 900 horsepower motors. The pumps are in good condition however, the 2006 Facility Review noted that the motors were extremely dirty. Build up of dirt and debris on the electrical equipment is very dangerous. Cleaning and maintenance of the pump motors was the subject of multiple Category 2 recommendations made as a result of the 2006 inspection. Concerns were also raised about the power cables connecting the pumping plant to the main overhead power lines.

The Toston Tunnel is made of concrete and is 2,044 feet in length. The tunnel appears to be in good condition with only a few spots of minor surface cracking. The Toston Canal is approximately eight miles long and has a capacity of 100 cfs. The 2006 inspection found all of the concrete structures to be in good condition. It was noted that boards needed to be replaced on a few check structures.

The Lombard Pipeline is about three miles long and carries about 30 cfs to the northern portion of the Unit. The pipeline was installed approximately five years ago to replace the Lombard Canal. The pipeline is operating well with no reported problems.

4.2.8.2 East Bench Unit

The East Bench Unit is in southwestern Montana, along the Beaverhead River. The unit provides full service and supplemental irrigation to approximately 30,000 acres. Project features include, the Clark Canyon Dam and Reservoir, the Barretts Diversion Dam, forty-four miles of main canal and multiple laterals, pipelines and drains. The Unit is managed by the East Bench Irrigation District.

The Clark Canyon Dam was not inspected as part of the recent (2006) Facility Review of the East Bench Unit. Clark Canyon Reservoir supplies irrigation water to multiple irrigation water supply organizations and is also a popular recreation area.

The Barretts Diversion Dam diverts water from the Beaverhead River about eight miles southwest of Dillon, MT. The initial capacity of the diversion is 440 cfs. In addition to the East Bench Canal, the diversion dam also serves the Canyon Canal operated by the Clark Canyon Water Supply Company. Water is diverted from the Canyon Canal into the Bolick or Reibach Ditch.

The diversion structure includes a 10 ft X 24 ft radial spillway gate, a 10 ft X 8 ft sluiceway gate and two 8 ft X 10 ft east Bench Canal radial gates. Operation of the main canal gates in automated. The automation system was recently repaired and is operating well. The metal gates and concrete of the diversion structure are in good condition. There is some woody vegetation adjacent to the structure that needs to be removed.

The East Bench Canal and access roads are in good condition. There are many bridges crossing the canal and the District inspects these every year. Planks are replaced as necessary. The major check structures along the canal are in good condition. The District noted a problem with seepage at a residence near the ditch which will require on-going observation to determine the best resolution to this problem. The District has also experienced a problem with a local feedlot that discharges water into the canal.

The laterals and pipelines that were inspected during the 2006 Facility Review were all in good condition. The District reshapes the laterals as necessary and recently replaced a washed out drop structure. This project is operating well. No major infrastructure related issues were reported during the 2006 inspection.

4.2.8.3 Helena Valley Unit

The Helena Valley Unit provides irrigation water for approximately 22,000 acres in the area northeast of Helena, MT. Features of the Unit include the Helena Valley Penstock, Pumping Plant and Tunnel. The Unit is managed by the Helena Valley Irrigation District.

Water is diverted from the Missouri River through a 12 ft X 21 ft fixed-wheel gate and hydraulic hoist which is installed on the upstream face of Canyon Ferry Dam. Water then flows into the 10 ft diameter steel penstock and is delivered to the pumping plant which is located approximately 500 feet downstream from Canyon Ferry Dam. There are two pumping units in the plant each consisting of a hydraulic turbine connected to a centrifugal pump. Each pump is designed to deliver 150 cfs.

The steel penstock was in fair to good condition at the time of the 2007 Facility Review of the Helena Valley Pumping Plant. One problem that was noted however, was some cracking of the concrete thrust blocks that support the penstock. Measurements need to be taken to determine the rate at which the cracks are growing. The 2007 inspection noted that the butterfly vales leading into the pumping plant need repair and recoating.

The pumps and turbines are in good operating condition. The pumping plant building, control equipment and the overhead cranes used to move heavy equipment are generally in fair to good condition. There are a few locations where the metal coating is failing, allowing surfaces to corrode. Corrective action will prevent further damage to any of these structures. The discharge pipe into the Helena Valley tunnel was also in fair to good condition. The Tunnel was not inspected during the 2007 facility review.

4.2.9 The Sun River Project

The Sun River Project is composed of the Fort Shaw and Greenfields Divisions located in central Montana, west of the city of Great Falls. The Fort Shaw Division provides irrigation water to approximately 10,150 acres and the Greenfields Division provides irrigation water to approximately 81,000 acres. Principal features of the project are Gibson Dam and Reservoir, Willow Creek Dam and Reservoir, Pishkun Dikes and Reservoir, Sun River Diversion Dam, Fort Shaw Diversion Dam, and nine canal systems.

4.2.9.1 Fort Shaw Division

The Fort Shaw project works were constructed in 1907 and 1908. This division is managed by the Fort Shaw Irrigation District. The Fort Shaw Diversion Dam diverts water from the Sun River into the Main Canal near Fort Shaw, MT. The diversion dam consists of a low rock weir constructed across the Sun River Channel. The headgate structure is made of concrete and is equipped with for metal gates with motorized operators. The District recently made repairs to the diversion dam however, this is a constant maintenance issue. During the 2007 Facility Review, it was noted that the concrete on the upstream side of the headgate structure is deteriorating.

The Fort Shaw Main Canal is 12.1 miles long and has an initial capacity of 225 cfs. The 2007 inspection revealed that most of the structures along the main canal are in good condition. The District has kept up with replacing walkway boards on structures as needed and has completely replaced some structures that were beyond repair. There is significant concrete deterioration on one major drop structure, the Sequist Drop; however, the structure is still able to operate adequately. Sealing some of the smaller cracks may extend the life of this structure.

There is one major siphon on the system, the Simms Creek Siphon. The concrete on the exterior of this structure is deteriorating in several locations. In one location, the damage is so extensive that the rebar is exposed. It was recommended that this section be repaired as soon as possible.

The portions of the laterals that were observed during the 2007 inspection were operating at full capacity. The District has been working to replace open ditch laterals with pipelines and to line some of the canals to improve delivery efficiency.

4.2.9.2 Greenfields Division

Construction on the Greenfields Division of the Sun River Project began in 1913 and water was first delivered in 1920. This division is managed by the Greenfields Irrigation District. The Greenfields Division is quite extensive. There are 8 main canals namely, the Willow Creek Feeder Canal, the Pishkun Supply Canal, the Sun River Slope Canal, the Spring Valley Canal, the Greenfields Main Canal, The Greenfields South Canal, the Mill Coulee Canal and the Beal or Big Coulee Canal. The Greenfields Irrigation District receives stored water from Gibson, Pishkun and Willow Creek reservoirs.

The Willow Creek Feeder Canal takes water from the Pishkun Supply Canal and diverts it into Willow Creek Reservoir. The canal is 7.5 miles long and has a maximum capacity of 500 cfs, although flows are currently limited to 75 cfs to reduce erosion issues. The 2005 Facility Review noted a seepage problem on the canal about one mile upstream from the point where the canal empties into the natural channel of Willow Creek. Further investigation was recommended. Woody vegetation along the canal was noted as a problem.

The Sun River Diversion Dam is located about three miles downstream of Gibson Reservoir on the Sun River. The diversion dam is a concrete structure that spans 261 feet across the river. It diverts water into the Pishkun Supply Canal which has an initial capacity of 1,400 cfs. Just downstream of the initial diversion, the canal enters a 700 ft long siphon which carries it across the Sun River to the north side. In addition to the siphon, the canal runs through two tunnels, 980 ft and 2,280 ft long, however, these structures were not inspected during the 2005 review as the structures were boarded up for the winter. The canal was in good condition with only a few locations where woody vegetation needed to be removed.

The Sun River Slope Canal runs eighteen miles from Pishkun Reservoir to the Spring Valley check structure. The design capacity of this canal is 1,600 cfs. The canal and the check structures that were observed during the 2005 inspection were in good condition.

The Spring Valley Canal extends fourteen miles from the end of the Sun River Slope Canal to the Greenfields Main Canal. The capacity of this canal is 1,200 cfs. The canal is generally in good condition. There is some erosion below one of the check structures. The District has done a good job of maintaining the points where concrete of the check and drop structures meet the natural canal material with shotcrete.

The Greenfields Main canal is 25.4 miles long and has an initial capacity of 1,200 cfs. The canal and drop structures are in good condition. The radial gates located at the point where the Main Canal divides from the Greenfields South Canal are somewhat worn however, they are still in fair condition.

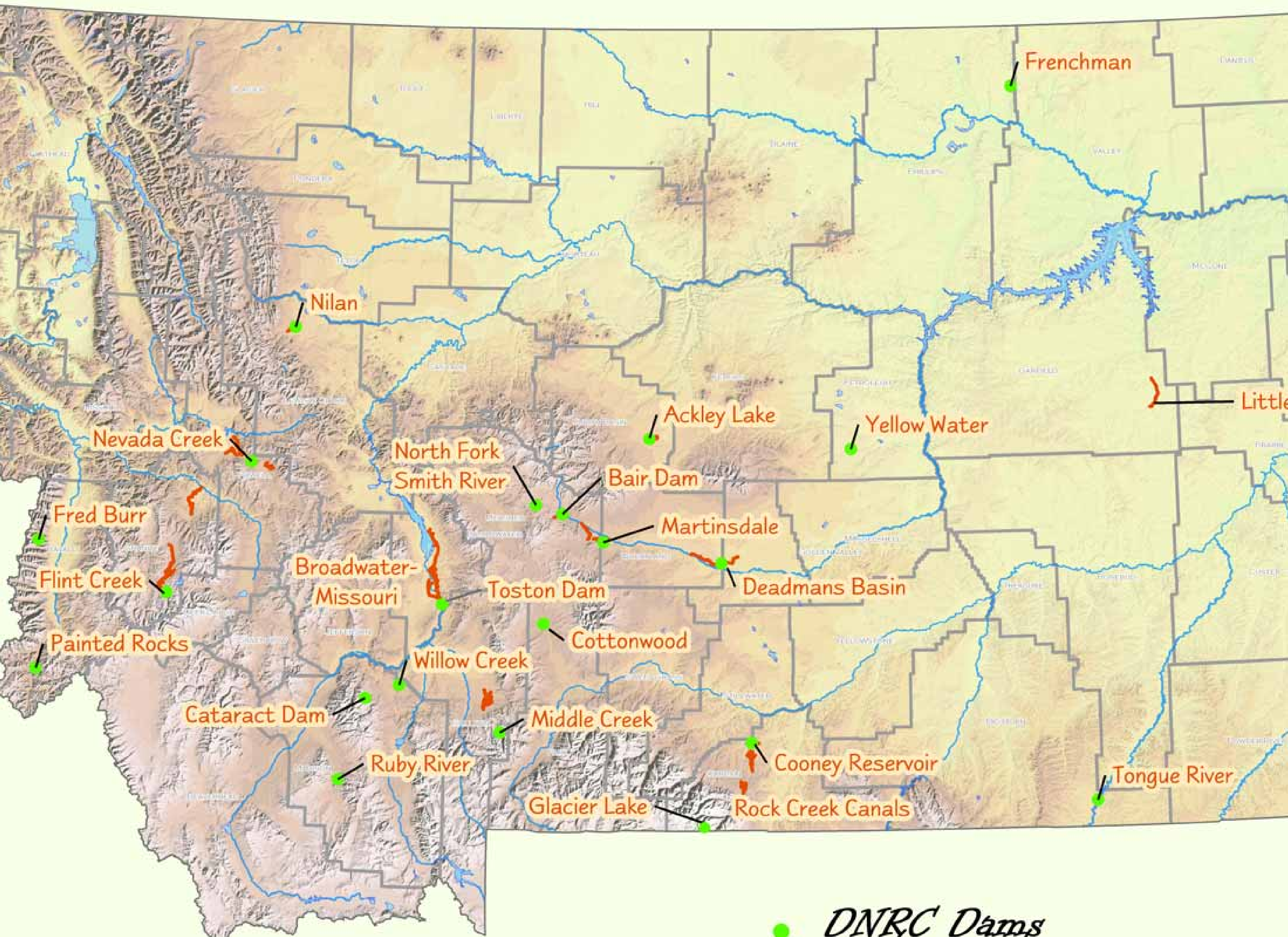
The Greenfields South Canal is 16.7 miles long with an initial capacity of 425 cfs and the Mill Coulee Cana is 10.7 miles long with and initial capacity of 200 cfs. Both of these canals are in good condition and are well maintained. The entire Greenfields system is on good working order. Items of note during the 2005 inspection were mainly related to the need for removal of woody vegetation in the upper reaches of the system.

4.3 State Water Projects Systems

The DNRC State Water Project Bureau (SWP) owns and manages twenty dams and ten canal systems. See Figure 4 for a map depicting the location of these systems. Management duties carried out by SWP include; conducting annual inspections, preparing and updating Emergency Action Plans, preparing and updating Operation and Maintenance Manuals, monitoring dam performance, conducting and overseeing engineering design and construction work (including hiring and managing consultants and contractors) to conduct repair and rehabilitation work. SWP has a water marketing contract with a water user's association (WUA) for each of these systems. The WUAs are responsible for operating and maintaining the facilities which involves hiring dam tenders and ditch riders to deliver water to members of the WUA and collecting fees. The fees pay for a dam tender/ditch rider, administrative costs of operating the Association, operation and maintenance fees paid to the State and for repairs and rehabilitation.

SWP has developed detailed descriptions for each of the dams which is presented below. Following that is a table listing the canal systems and the estimate replacement cost for each of those systems. SWP also was able to supply information about recent expenditures and predicted future costs for work that has already been identified.

Irrigation Project Dams and Canals



4.3.1 Ackley Lake Dam

4.3.1.1 Project Description

Ackley Lake Dam is an off-stream storage project located in Judith Basin County, five miles southwest of Hobson. It is owned by DNRC & managed by the State Water Projects Bureau (SWPB), and has been operated by the Ackley Lake Water Users Association since 1938. Ackley Lake Dam is a popular recreation site. Ackley Lake State Park, managed under lease by the Dept. of Fish, Wildlife & Parks, surrounds the northern half of the reservoir.

This project consists of an earthen embankment dam, 51 feet high, 3,514 feet long and an unregulated, trapezoidal earthen section spillway, 4-foot diameter corrugated 8-gauge metal pipe outlet conduit and 48-inch diameter slide gate valve, which is manually operated. The dam was constructed in 1938 by the State Water Conservation Board. Storage at full pool is 5,975 acre-feet in volume, has 260 surface acres and is located off stream of the Judith River. The main watershed intercepted by the supply canal is Antelope Creek, with a drainage area of 2.6 square miles. Twenty-seven water users have 53 contracts for 4,766 acre/feet of water.

4.3.1.2 Project Deficiencies/Rehabilitation

Excessive uplift pressure may threaten structural integrity of the dam. A corrugated metal outlet and drain pipes have exceeded design life and need replacement. A pool level restriction has been in place due to risk of failure.

Rehabilitation of the dam will significantly reduce the potential for loss of life and would provide for the continued use of the reservoir for agricultural irrigation, recreation and fisheries. The structure does not meet Montana Dam Safety Act standards. Rehabilitation would bring the structure up to code and extend its useful life for another 50 to 75 years. The estimated future rehabilitation cost is $1,487,257.

Funding was approved by the 2007 Legislature. Rehabilitation will include the installation of new drains, outlet conduit lining, an earthen berm to reinforce the dam embankment, and a new primary and emergency spillway. Upon completion, the project will meet all current safety standards. The rehabilitation project is scheduled for completion in the spring of 2009.

4.3.2 Bair Dam

4.3.2.1 Project Description

Bair Dam is located on the North Fork of the Musselshell River in Meagher County, approximately ¾ mile upstream of Checkerboard. It is owned by DNRC & managed by SWPB, and has been operated by Upper Musselshell Water Users Association (WUA) since 1940.

This project consists of the 102 foot high dam, and a concrete chute spillway, a gated, reinforced concrete outlet conduit, a 48-inch butterfly operating gate, and a 48-inch emergency slide gate with manual operators located in a gate house on the dam crest. Original construction was completed in 1939. Normal storage at full pool is 7,300 acre-feet, and eleven water users have twenty-one contracts. This project irrigates approximately 4,100 acres with three canals: 1) Northfork Diversion Canal (11.7 miles long), 2) Checkerboard Canal (2.9 miles long) and 3) Two Dot Canal (32.2 miles long). The dam is a “high hazard” structure which means that its failure could cause loss of life: 94 people would potentially be impacted. Checkerboard, numerous houses, roads, bridges, and utilities are located in the flood plain.

4.3.2.2 Project Deficiencies/Rehabilitation

The Bair Dam was rehabilitated in 2003. The dam now meets all current safety standards, with an expected design life of 50 to 75 years. A new structural concrete spillway was constructed in same location as the old one. The steep slope above spillway was excavated to create a gentler slope to alleviate creep and rock fall. A new concrete conduit outlet structure was installed, and an additional toe berm was constructed to buttress downstream embankment. Finally, a new control house, fence, security gates and access road were all constructed. The recent rehabilitation cost was $2,738,562.

4.3.3 Cataract Creek Dam

4.3.3.1 Project Description

Cataract Creek Dam is an impoundment on Cataract Creek, from Mason Lake which is a tributary of N. Willow Creek. It is located approximately eight miles southwest of Harrison in Madison Co. It is owned by DNRC & managed by SWPB, and has been operated by Cataract Creek Water Users Association since 1959.

This project consists of an earthen embankment dam, 80 feet high, and 775 feet long. It has a controlled, unlined open channel spillway with concrete drop structure, and a 30-inch, horseshoe-shaped 390 foot-long reinforced concrete outlet, with two 30-inch diameter gate valves in series. The original construction was completed in 1959. The reservoir stores 1,478 acre-feet at spillway crest and provides irrigation water for sixteen farms and ranches. The dam is a "high hazard" structure, which means that its failure could cause loss of life. Farms and ranches, roads, bridges, and utilities are located in the flood plain. The towns of Pony and Harrison are immediately downstream.

4.3.3.2 Project Deficiencies/Rehabilitation

The existing spillway earthen channel is not capable of safely passing the design flood event. Excessive seepage in the right abutment may threaten structural integrity.

A two-phased rehabilitation process is planned. The first phase requires engineering analysis and alternative evaluation to determine the best course of action to address deficiencies. Funding for phase 1 was approved by the 2007 Legislature. The second phase includes the final design and construction. The proposed rehabilitation would include construction of new spillway and channel that meets current standards, and installation of a new seepage collection and drain system. The estimated future rehabilitation cost is $2,000,000.

4.3.4 Cooney Dam

4.3.4.1 Project Description

Cooney Dam is an impoundment on Red Lodge Creek. It also obtains water from Willow Creek and Glacier Lake Reservoir. It is located approximately eight miles west of Boyd in Carbon County. Cooney Dam is owned by DNRC & managed by SWPB, and has been operated by the Rock Creek Water Users Association since 1937.

This project consists of an earthfill dam, 102 feet high, and 2,369 feet long. There is a controlled, ogee crest principle spillway with concrete drop structure in the left abutment and a fuse plug emergency spillway. It has a 6-foot horseshoe-shaped 630 foot-long concrete outlet, with two 60-inch diameter gate valves (butterfly operating gate and emergency slide gate), in series. The original construction was completed in 1937. The dam stores 28,230 acre-feet at its crest; surface area at normal full pool – 1,078 acres.

Cooney Dam provides irrigation water on approximately 20,000 acres and is a popular recreation site, with Cooney State Park, managed under lease by the MT Dept. of Fish, Wildlife & Parks, encompassing the north, east and south shore of the reservoir. The dam is a "high hazard" structure, which means that its failure could cause loss of life. Farms and ranches, roads, bridges, and utilities are located in the flood plain. The towns of Boyd and Joliet are immediately downstream.

4.3.4.2 Project Deficiencies/Rehabilitation

In 1982 the dam was raised five feet and rehabilitated. The dam, spillways and outlet works are in good condition and meet or exceed existing dam safety standards. The rehabilitation included raising the dam embankment five feet. The principle spillway was replaced, and a guard dike was added in the spillway approach channel. A fuse plug emergency spillway was added, and the wooden bridge was replaced over the principle spillway with a concrete bridge. Additional drains were also installed. The recent rehabilitation cost (1982) was $1,288,065.

4.3.5 Cottonwood Dam

4.3.5.1 Project Description

Cottonwood Dam impounds Cottonwood Creek in Park County, and is located approximately five miles north of Wilsall. It is owned by DNRC & managed by SWPB, and has been operated by the Shields Canal Company since 1953.

The project consists of an earthen embankment dam, thirty-nine feet high, and 610 feet long. There is an earthfill dike, eight feet high, 825 feet long. It has an uncontrolled guard dike spillway with ogee crested chute and baffle blocks, and a 36-inch, 197 foot-long corrugated steel pipe outlet with 36-inch vertical slide gate in a rectangular wet tower with controls at the dam crest. The original construction was completed in 1953. The reservoir capacity is 1,905 acre-feet at spillway crest, covering 235 surface acres. 1379 acre-feet is under contract with the Shields Canal Company. The dam is a "high hazard" structure, which means that its failure could cause loss of life. Numerous farms and ranches, roads, bridges, and utilities are located in the flood plain.

4.3.5.2 Project Deficiencies/Rehabilitation

Existing drains and outlet conduit are deteriorating and at the end of design life. The spillway is undersized and does not meet current safety standards.

Proposed rehabilitation includes replacing the spillway or increase freeboard to meet current spillway standards, constructing an auxiliary spillway, replacing the outlet conduit with a new structure, and installing new drains for seepage control. The estimated future rehabilitation cost could exceed $1,500,000.

4.3.6 Deadman's Basin Dam

4.3.6.1 Project Description

Deadman's Basin is an off-stream reservoir served by a supply canal from the Musselshell River, and is located approximately ten miles east of Harlowton in Wheatland Co. It is owned by DNRC & managed by SWPB, and has been operated by Deadman's Basin Water Users Association since 1959

The project consists of an earthen embankment dam, 80 feet high, 775 feet long, and an earthen embankment dike, 18 feet high, 2,950 feet long. There is a horseshoe-shaped 300-foot long reinforced concrete outlet tunnel, with two 60-x 60-inch cast iron slide gates with vertical access tower. The 11.5 mile supply canal has a capacity of 600 cfs, and two delivery canals totaling 12.5 miles in length. The original construction was completed in 1941. The dam was raised ten feet in 1958.

The reservoir stores 76,900 acre-feet at normal full pool, covering 2,120 surface acres. It provides irrigation water for sixteen farms and ranches. The dam is a "high hazard" structure, which means that its failure could cause loss of life. Farms and ranches, roads, bridges, and utilities are located in the flood plain. Melstone, Ryegate, and Roundup are dependent on the water from the reservoir for their municipal water systems, and 490 families, including ranchers, farmers, and residents of small towns, directly depend on receiving their contracted water shares from the Deadman's Basin Water Project.

4.3.6.2 Project Deficiencies/Rehabilitation

Excessive seepage and uplift pressures require the installation of a drain system and toe berm. Additional requirements include conduit extension, building a new energy dissipating outlet, and constructing a fifteen foot high toe berm with a filter. Estimated rehabilitation costs are $1,077,852.

4.3.7 Fred Burr Dam

4.3.7.1 Project Description

Fred Burr Dam is located on public land in the Bitterroot National Forest in Ravalli County, nine miles southwest of Victor. It impounds the headwaters of Fred Burr Creek. The dam is owned by DNRC & managed by SWPB under a US Forest Service Special Use Permit, and has been operated by Fred Burr Water Users Association since 1948

The project consists of a rolled earthfill embankment dam, 50 feet high, and 325 feet long. There is a twenty foot wide, 120 foot-long, concrete lined rectangular chute spillway with 4.3 foot-high radial gate, and four-foot diameter reinforced concrete conduit, single cell wet tower with control mechanism at the top of the tower on the dam crest. It has a manually operated 48-inch diameter slide gate. The original construction was completed in 1948 (the dam was breeched during a high runoff episode in the spring of 1948; the dam was reconstructed in 1949). The reservoir stores 525 acre-feet at normal full pool and covers twenty-eight surface acres.

4.3.7.2 Project Deficiencies/Rehabilitation

The spillway is nearing the end of its design life and will require future replacement. Replacement is needed due to concrete deterioration from age. Current safety standards may require a substantial increase in spillway capacity. The concrete outlet is deteriorating and needs repair. Lining or replacing the outlet are anticipated to be the primary options to correct the deficiencies.

Proposed rehabilitation includes constructing a new spillway that meets or exceeds current safety standards, and lining the existing outlet or replace with a new structure. The estimated future rehabilitation cost could exceed $2,000,000.

4.3.8 Frenchman Dam

4.3.8.1 Project Description

Frenchman Dam impounds Frenchman Creek in Phillips County, and is located approximately twenty miles north of Saco. It is owned by DNRC & managed by SWPB, and has been operated by Frenchman Water Users Association since 1952.

The project consists of an earthen embankment dam, forty-four feet high, and 2,100 feet long. It has a reinforced concrete spillway, 119 feet wide, with uncontrolled ogee crest. There is a 60-inch, 230 foot long reinforced concrete outlet with two 60-inch slide gates (one emergency and one operating). The original construction was completed in 1951; the dam failed during a flood in 1952 and was subsequently rebuilt. The reservoir storage design capacity was 7,010 acre-feet at spillway crest (see deficiencies), covering an estimated 800 to 1,000 surface acres. There are nineteen water users who use stored water on approximately 7,000 acres of irrigated land.

4.3.8.2 Project Deficiencies/Rehabilitation
Voids underneath the spillway and offset joints indicate progressive deterioration. Sedimentation has greatly diminished the storage capacity by about 50% (based on aerial photography, the existing capacity is estimated at 3752 acre-feet).

A feasibility study was funded by the 2007 Legislature to determine the best alternatives for rehabilitation. The rehabilitation would include replacing the spillway with a new structure and restoring lost storage capacity. The estimated future rehabilitation cost may exceed $3,000,000.

4.3.9 Glacier Lake Dam
4.3.9.1 Project Description
Glacier Lake Dam is located on Rock Creek thirty-five miles southwest of Red Lodge on the Custer National Forest. It was constructed by the State Water Conservation Board in 1937. It is owned by DNRC & managed by SWPB under a US Forest Service Special Use Permit. It has been operated by Rock Creek Water Users Association since 1937.

Glacier Lake is a natural lake. The 1937 construction of two dams on the lake created additional storage capacity. Post construction full-pool storage is 4,200 acre-feet with a surface area of 151 acres. The project consists of two rockfill dams, each with a concrete upstream face: North Dam (57 feet high, 230 feet long) and South Dam (twenty feet high, 253 feet long). An uncontrolled rock channel spillway discharges over a low concrete weir. The low level outlet is a blasted rock tunnel beneath the North Dam, approximately 6.5 feet high by 5.5 feet wide. The outlet is controlled by one 48-x 48-inch rectangular slide gate. The operating controls are in a wooden gatehouse located on the North Dam crest. The dam is a “high hazard” structure, which means that its failure could cause loss of life. Farms and ranches, roads, bridges, and utilities are located in the flood plain.

4.3.9.2 Project Deficiencies/Rehabilitation
The spillway does not meet current safety standards.

The proposed rehabilitation is to construct a new spillway that meets or exceeds current safety standards. The estimated future rehabilitation cost could exceed $2,000,000.

4.3.10 Martinsdale Dam
4.3.10.1 Project Description
Martinsdale Dam is an off stream storage project, in Wheatland and Meagher Counties, located 2.5 miles southeast of Martinsdale. It is owned by DNRC & managed by SWPB, and has been operated by Upper Musselshell Water Users Association since 1939.

The project consists of two ‘zoned’ earthfill dams: the North Dam (91 feet high, 1,000 feet long) and the East Dam, forty-nine feet high, 1,550 feet long). There is a gated, reinforced concrete 60-inch outlet conduit, a concrete chute spillway 120 feet long, a 54-inch emergency slide gate, an earth-rock lined emergency spillway and 54-inch operating butterfly valve with controls at the top of the tower. The dam was constructed in 1939. Storage at full pool is 23,348 acre-feet covering 985 surface acres, and 86 water users have 101 contracts for 21,718 acre/feet of water. The delivery of irrigation water is vitally important to the water user farm/ranch operations. The dam is a popular recreation site, primarily for fishing. A DFWP Fishing Access Site is located on the reservoir's north shore.

4.3.10.2 Project Deficiencies/Rehabilitation

Large amounts of seepage occur in the north dam. Grouting for seepage control has had limited success. Additional drains were installed in 1985 to collect seepage and improve embankment stability. The configuration of the existing drains makes it unsafe and difficult to monitor flows. In addition, sedimentation is occurring in the toe drain and cannot be accurately measured. Excessive seepage and sedimentation may indicate a potential problem within the dam, but this cannot be determined with the existing drain configuration. In order to improve seepage collection and make accurate measurements of flows and sedimentation, modification of the drains will be necessary.

The drain system should be modified to allow accurate and safe measurements of flows and sedimentation, including adding manholes to the toe drain system for flow measurements and trapping sediment. The outfall of the right abutment horizontal drain system should be redirected further downstream to allow for safe and accurate flow measurements. It will also be necessary to install a right groin drainage system to address the remaining seepage, and install automated instrumentation to allow for continual monitoring. These improved monitoring capabilities are required for compliance with the current operating permit. The estimated future rehabilitation cost is $129,525.

The Department is requesting a $100,000 Renewable Resource Grant from the 2009 Legislature for partial project payment. The DNRC will pay for remaining cost.

4.3.11 Middle Creek Dam (Hyalite)

4.3.11.1 Project Description

Middle Creek Dam (Hyalite) is located on Middle Creek, fifteen miles south of Bozeman on the Gallatin Forest in Gallatin Co. It is owned by DNRC & managed by SWPB under a US Forest Service Special Use Permit, and has been operated by Middle Creek Water Users Association since 1951.

The project consists of an earthen dam with concrete panels on downstream side, 125 ft. high, and 1,900 ft. long. It has a five-foot diameter, "cast in place" steel-lined concrete conduit and one, 54-inch diameter butterfly operating gate and a 54-inch emergency gate valve. The gate valves are operated from a tower on the dam crest. The principal spillway has a labyrinth crest inlet and two baffled apron type spillway chutes. The auxiliary spillway is earth lined with a 530 foot-long concrete crest. The original construction was completed in 1951. Hyalite reservoir stores 10,184 acre-feet at normal full pool, covering 490 surface acres. It provides irrigation water for 73 farms and ranches and drinking water for 2,000 households (1/3 of the City of Bozeman water supply is provided by the project). The dam is a "high hazard" structure, which means that its failure could cause loss of life. Farms and ranches, homes, schools, roads, bridges and utilities are in the flood plain.

4.3.11.2 Project Deficiencies/Rehabilitation

No deficiencies currently exist. The dam embankment was raised ten feet in 1991-1992 as part of a major rehabilitation that included a new spillway, outlet conduit and seepage and drain system. The project meets all current safety standards. The project cost (in 1992 Dollars) was $5,200,000. Funding was secured through a federal loan.

An updated automated instrumentation system will be installed in the fall of 2008. The new system will improve seepage, drain flow and reservoir monitoring. Included as part of this project was a feasibility study on installing an early warning system. The estimated future rehabilitation cost is $137,525.

4.3.12 Nevada Creek Dam

4.3.12.1 Project Description

Nevada Creek Dam is located on Nevada Creek in Powell County, adjacent to State Hwy 141, between Avon and Helmville. Nevada Creek is a major tributary of the Blackout River. The dam is owned by DNRC & managed by SWPB, and has been operated by Nevada Creek WUA since 1939.

The project consists of an earthfill dam, 105 feet high, and 1,083 feet long. There is an uncontrolled ogee crest concrete chute spillway and a five-foot diameter, 472 foot-long, gated, reinforced concrete outlet conduit. It has a 54-inch diameter gate valve upstream (emergency gate) and 54-inch butterfly valve (operating gate). The original construction was completed in 1938. Normal storage at spillway crest is 11,152 acre-feet, covering 368 surface acres. Seventeen water users have thirty-five contracts and irrigate approximately 5,600 acres with two canals: Douglas Canal (12.7 miles long) North Canal (13.4 miles long). The dam is a “high hazard” structure which means that its failure could cause loss of life. Numerous houses, roads, bridges, canals and utilities are located in the flood plain below the dam.

4.3.12.2 Project Deficiencies/Rehabilitation

A major rehabilitation was completed in 2003. The project included the replacement of the spillway, extension of the outlet works, relief wells to reduce foundation pressures, and the addition of a toe berm to enhance embankment stability. The rehabilitation brought the dam into full compliance with current dam safety standards. The recent rehabilitation cost was $2,000,000.

4.3.13 North Fork Smith River Dam

4.3.13.1 Project Description

The North Fork Smith River Dam is located on the North Fork of the Smith River in Meagher County, ten miles East of White Sulphur Springs. It is owned by DNRC & managed by SWPB, and has been operated by Smith River WUA since 1936.

The project consists of an earthen embankment dam, 84 feet high, and 1,300 feet long. There is a labyrinth weir spillway with excavated rock channel, a gated, reinforced concrete outlet conduit, and a 5-x 5-foot reinforced concrete, modified horseshoe shaped conduit with manually operated 54-inch diameter emergency slide gate and 54- inch butterfly operating gate.

The original construction was completed in 1936. Normal storage is 11,500 acre-feet, covering 335 surface acres. Twenty-nine water users have forty contracts and irrigate approximately 11,000 acres with one canal (Southside Canal; 13.2 miles long). The dam is a "high hazard" structure, which means that its failure could cause loss of life. Numerous roads, bridges, and utilities are located in the flood plain. White Sulphur Springs, (pop. 1,018) would begin flooding approximately three hours after failure of the dam.

4.3.13.2 Project Deficiencies/Rehabilitation
The dam was rehabilitated in 2006. The rehabilitation brought the dam into full compliance with current safety standards.

The rehabilitation included a new structural two-cycle labyrinth weir concrete spillway, raising and leveling the dam crest, and replacing the outlet works terminal structure with a new structure. Work also included enlarging the rock spillway channel and installing new drains for seepage control. The recent rehabilitation cost was $825,000.

4.3.14 Nilan Dams
4.3.14.1 Project Description
Nilan is an off-stream reservoir located seven miles west of Augusta in Lewis & Clark County. It is owned by DNRC & managed by SWPB, and has been operated by Nilan WUA since 1952. The reservoir is a popular recreation site, primarily for fishing. The DFWP manages a Fishing Access Site under a DNRC lease on the south shore of the reservoir.

The project consists of two dams: the North Dam (54 feet high, 530 feet long, no spillway), and the East Dam (51 feet high, 1010 feet long, concrete control section spillway). Each dam has a gated, reinforced concrete outlet conduit, and a 4-foot diameter cast-in-place reinforced concrete tunnel. Control towers at each dam are located on the dam crest, consisting of a double chambered wet tower with a 48-inch slide operating gate and 48-inch square emergency slide gate. Controls for the gates are located at the top of the towers.

The original construction was completed in 1951. Normal storage is 10,092 acre-feet, covering 525 surface acres. There are twenty-seven water users who have 53 contracts, and irrigate approximately 10,000 acres with two canals (12.7 mile-long North Canal; 5.8 mile-long East Canal). The dam is a "high hazard" structure, which means that its failure could cause loss of life. The town of Augusta (population 284) is located seven miles east and downstream of Nilan Reservoir. Numerous houses, roads, bridges, and utilities are located in the flood plain below the dam

4.3.14.2 Project Deficiencies/Rehabilitation
Several major repairs were completed on the East Dam in 1999 to repair sinkholes that developed along the upstream toe. A new outlet terminal structure and drain system was installed at the north dam in the spring of 2008.

4.3.15 Painted Rocks Dam
4.3.15.1 Project Description
Painted Rocks Dam is located on the West Fork of the Bitterroot River, thirty miles southwest of Darby in Ravalli Co. It is owned by DNRC, managed and operated by SWPB.

The project consists of a 143 feet-high, 800 foot-long rolled earthfill dam with impervious center. It has a reinforced concrete chute spillway, a circular 10-foot diameter concrete lined rock outlet tunnel, and a 10-foot diameter, horseshoe shaped reinforced concrete tunnel, with two 5-x 8-foot gates (one operating and one emergency), located at the bottom of a vertical wet tower. It was constructed in 1939. Storage at full pool is 32,362 acre-feet, covering 655 surface acres. DFWP purchases 15,000 acre-feet of water for downstream fisheries. The Painted Rocks Water Users Association has forty-one contracts for 10,000 acre-feet of water. Montana Fish, Wildlife & Parks pays half of the operating and maintenance costs, with the water users paying the remaining half.

4.3.15.2 Project Deficiencies/Rehabilitation

The spillway stilling basin floor is severely cracked. The spillway chute concrete is deteriorated and needs repairs or replacement. The spillway configuration has undesirable flow characteristics that reduce its safe capacity.

Repairs and maintenance are on-going and have included work on the operating gate. It was removed, repaired and reinstalled during the summer of 2008. Cost of the repair was $53,738, paid for by the water users. A feasibility study assessed the condition of the spillway and gate repairs and was completed in 2007. The cost was $130,874 and was paid by the DNRC. The emergency gate roller chain was replaced in 2006 at a cost of $50,377. The water users paid the majority of the cost. The gate hoist mechanism was rehabilitated in 2005. The $23,161 cost was paid for entirely by the water users. A new log boom and security fence were installed in 2004. The water users paid for the log boom and the DNRC for the fence. Costs: Log Boom – $20,453; Fence - $4,916. Future conduit and gate work may cost up to $14 million. A spillway rehabilitation study is on-going. The cost of the spillway rehabilitation could exceed $20 million.

4.3.16 Ruby Dam

4.3.16.1 Project Description

Ruby Dam is located on the Ruby River, in Madison County, seven miles south of Alder. It is owned by DNRC and has been operated by Ruby Water Users Association since 1938.

The project consists of an earthen embankment dam, 111 feet high, 846 feet long. It has a reinforced concrete chute spillway, and a gated, reinforced concrete 90-inch outlet conduit. It was constructed in 1938. Storage at full pool is 37,612 acre-feet, covering 970 surface acres. Two canals deliver water to purchasers: West Bench, twelve miles long, 85 cfs capacity; Vigilante, 26 miles long, 115 cfs capacity. There are 191 water users who have 225 contracts for 38,845 acre/feet of water.

4.3.16.2 Project Deficiencies/Rehabilitation

Severe concrete deterioration exists in the spillway floor and walls. Spillway replacement is needed to correct the deficiencies. Excessive seepage may threaten the structural integrity of the spillway.

A feasibility study to evaluate the problems at Ruby Dam at Ruby Dam was completed in 2007 by HLM Engineering of Billings. The $285,000 feasibility study cost was authorized by the 2006 Legislature and paid by the DNRC.

This project is in need of major rehabilitation. The preferred alternative identified in the feasibility study for rehabilitation calls for a new spillway, outlet conduit, drains, access road and additional storage that could be marketed for beneficial uses. These improvements would bring the dam into full compliance with current safety and design standards and greatly reduce the state's liability. The proposed rehabilitation will also allow for future hydropower development. The estimated future rehabilitation cost is $11,930,000.

4.3.17 Tongue River Dam

4.3.17.1 Project Description

The Tongue River Dam is located on the Tongue River in Big Horn County, five miles north of Decker. It is owned by DNRC & has been managed by the Tongue River Water Users Association since 1938.

The project consists of a zoned earthfill dam, 93 feet high, 1,824 feet long. There is an uncontrolled, 150 foot wide, 560 foot long concrete labyrinth weir principle spillway. The emergency spillway consists of roller compacted concrete with conventional concrete encasement stair step chute with an ogee crest, 650 feet wide. There is a 16-foot horseshoe-shaped concrete auxiliary outlet tunnel; downstream and upstream wet wells with a 4.5 foot by seven foot fixed wheel emergency gate and cast iron operating sluice gate.

The original construction was completed in 1940 by the State Water Conservation Board. The project stores 79,071 acre-feet at normal full pool, covering 3,700 surface acres. The dam is a very popular recreation site, with Tongue River State Park, managed under lease by the MT Dept. of Fish, Wildlife & Parks, located on the west shore of the reservoir. It provides a portion of the Northern Cheyenne Tribe's federally reserved water right. The dam is a "high hazard" structure, which means that its failure could cause loss of life. Farms and ranches, roads, bridges, and utilities are located in the flood plain.

4.3.17.2 Project Deficiencies/Rehabilitation

From 1996 to 1999 the DNRC completed a major rehabilitation of the dam. The dam, spillways and outlet works are in good condition and meet or exceed existing dam safety standards. The rehabilitation included raising the dam crest an additional four feet, providing up to an additional 20,000 acre-feet of storage. A new primary outlet tunnel and emergency spillway was constructed, and the principle spillway was replaced. Improvements were made to the drain system, and to access and maintenance roads. The 1999 rehabilitation cost was $52,000,000.

The rehabilitation costs were shared between the DNRC, US Bureau of Reclamation and Northern Cheyenne Tribe. Repairs are continuing on cracks that have appeared in the emergency spillway concrete steps. The estimated future rehabilitation cost of the crack repairs is $500,000.

4.3.18 Toston Dam (Broadwater-Missouri)

4.3.18.1 Project Description

The Toston Dam is located on the Missouri River, in Broadwater County, six miles southeast of Toston. It is owned and operated by the DNRC.

The project consists of a concrete gravity dam, 56 feet high, 705 feet long. It is a run-of-the-river dam, with rubber inflatable bladder flashboards. The project includes a 10-megawatt hydropower power. Northwest Energy purchases power from the plant. Hydropower revenue, which totals approximately $900,000 after debt payments and operating expenses, is used for rehabilitation and repairs on other state-owned projects.

The original construction was completed in 1940 by State Water Conservation Board. It stores 3,000 acre-feet at normal full pool. It provides supplemental irrigation on approximately 23,600 acres through the Broadwater-Missouri Canal. The dam is a "high hazard" structure, which means that its failure could cause loss of life. Farms and ranches, roads, bridges, towns and utilities are located in the flood plain.

4.3.18.2 Project Deficiencies/Rehabilitation
A major rehabilitation of the dam occurred in 1989. The dam, spillway and hydropower plant are in good condition and meet or exceed existing dam safety standards. The rehabilitation included construction of new rubber bladder flashboards to control pool levels. The 10-megawatt hydropower plant was installed, and improvements were made to access and maintenance roads. The 1989 rehabilitation cost was $26,000,000.

The spillway bridge was replaced in 2005 at a cost of $675,000. The bridge serves as a primary maintenance access and provides public access to the east side of the river. A new automated track rake was installed in 2002. The trash rake cleans debris from the upstream face of the dam and greatly reduces the frequency of shutdowns of the power plant for intake cleaning and maintenance. The 2002 rehabilitation cost was $450,000.

4.3.19 Willow Creek Dam
4.3.19.1 Project Description
Willow Creek Dam impounds Willow and Norwegian Creeks, located in Madison County, 3.5 miles east of Harrison. It was constructed in 1938, and is owned by DNRC. It has been operated by the Willow Creek Water Users Association since 1938.

The project consists of a 105 feet high, 453 foot long, zoned earth and rock fill dam. There is an uncontrolled ogee crest concrete chute spillway, a 60-inch horseshoe shaped 362 foot long concrete outlet conduit, and one 54-inch main operating butterfly valve and one 54-inch emergency gate valve. Storage at full pool is 18,000 acre-feet, covering 885 surface acres. The Willow Creek Water Users Association has 151 contracts for 11,900 acre-feet of water The reservoir is a popular recreation site. The Dept. of Fish, Wildlife & Parks, under a DNRC lease, manages a Fishing Access Site on the west shore of the reservoir .

4.3.19.2 Project Deficiencies/Rehabilitation
The spillway does not meet current safety standards and is not capable of passing the design flood event. The outlet conduit also needs to be assessed for deficiencies. Age related concrete deterioration exists in the spillway wall, floors, and outlet conduit.

Replace the spillway with a new structure that meets current safety design standards. Install a new outlet conduit. The estimated future rehabilitation cost is $4,000,000.

4.3.20 Yellow Water Dam
4.3.20.1 Project Description
Yellow Water Dam impounds Yellow Water Creek, located in Petroleum County, twelve miles southwest of Winnett. It was constructed in 1938. The dam is owned by DNRC; and has been operated by the Yellow Water Users Association since 1938.

The project consists of a thirty-seven foot high, 1,695 foot-long, earthfill dam. There is an uncontrolled trapezoidal earth and rock lined spillway, a 42-inch reinforced concrete pipe outlet (150 foot-long), and one 42-inch slide gate valve with manual operator.

Storage at full pool is 3,842 acre-feet, covering 490 surface acres. The Yellow Water Users Association has four contracts for 2,000 acre-feet of water. The west and south shores of the reservoir are part of the War Horse National Wildlife Refuge, managed by the US Fish and Wildlife Service. The reservoir serves as an important nesting area for waterfowl. The dam is a "high hazard" structure, which means that its failure could cause loss of life.

4.3.20.2 Project Deficiencies/Rehabilitation

By 1979 the original spillway was eroding and starting to threaten the embankment. A new spillway was configured running parallel to the embankment utilizing the original spillway entrance. In 1980, the Army Corps of Engineers performed an inspection and condemned the outlet due to excessive corrosion of the original CMP. Yellow Water Dam underwent a two phase rehabilitation project in 1985. Phase I included the embankment excavation and removal of the original outlet conduit. Phase II included the construction of a new outlet conduit (42-inch diameter reinforced concrete pipe), the inlet and outlet structures, cleaning the original gate and placing riprap on a portion of the upstream face. In 2004, the SWP installed five monitoring wells with deep and shallow piezometers to enhance the monitoring program. The reservoir has not filled since that time.

The intake structure has a history of plugging up with sediment when the gate is closed during the off season. The intake structure may have to be modified or redesigned and replaced to prevent plugging. Seepage has been observed in the vicinity of the left abutment. The drain system may have to be improved to better control and monitor seepage flows. The estimated future rehabilitation cost is $500,000.

4.3.21 State Canal Systems

In addition to the dams, the SWP is responsible ten canal systems. Table 3 below lists the canal systems, the date each was completed, the length and flow capacity and the estimated reconstruction cost based on 2002 cost data. According to SWP's project engineer, approximately $2.5 million have been spent in the past five years. This includes grants and loans from the State and Federal government, technical assistance provided by SWP and funds from the water users associations. It is estimated that there are $2.5 - $3 million worth of projects that need to be completed in the next five years.

State Project	Completion Date	Length (mi.)	Flow (cfs)	Estimated Reconstruction Cost (2002)
Ackley Lake	1933			**$924,746**
Supply		6.7	100	$584,566
Outlet		4.7	62	$340,180
Broadwater-Missouri	1940			**$6,373,986**
Main		1.5	342	$267,095
West		12.4	90	$1,031,997
East		34.3	262	$5,074,894
Deadman's Basin	1941			
Supply		11.5	600	**$2,053,927**
Careless Cr		9.5	344	$1,698,752
Barber		2.9	200	$355,176
Flint Creek	1938			**$3,990,289**
Main		7.7	200	$959,597
East		5.8	63	$424,504
Marshall		16.0	56	$1,128,289
Allendale		13.0	125	$1,249,312
Metcalf		4.1	17	$228,586
Little Dry	1938			**$965,417**
Canal		11.6	90	$965,417
Middle Creek	1951			**$321,949**
Cottonwood		4.1	77	$321,949
Nevada Creek	1938			**$1,767,429**
Douglas		12.6	50	$858,967
North		13.4	49	$908,462
Nilan	1951			**$887,546**
Supply		5.5	300	$887,546
Rock Creek	1937			**$1,318,463**
Point of Rocks		2.3	50	$156,796
Finn		9.0	25	$528,872
Cottonwood		2.0	25	$117,527
Pryde		8.0	40	$515,269
Upper Musselshell	1939			**$5,222,324**
Checkerboard		2.9	38	$184,602
N.Fk. Diversion		11.7	105	$1,039,787
Martinsdale Supply		2.4	408	$488,993
Martinsdale Outlet		2.6	333	$448,918
Two Dot		32.1	122	$3,060,024
Totals		**250.2**		**$23,826,076**

Table 9. *Value Assessment of State-Owned Canals.*

5.0 Inventory

The 60th Montana State Legislature approved funding to prepare an inventory of irrigation infrastructure in Montana. The purpose of the inventory is to provide the Montana Department of Natural Resources and Conservation (DNRC) and other decision makers with an understanding of the condition of existing irrigation systems throughout Montana and an estimated cost of completing necessary improvements. Many irrigators, agency personnel and others recognize that there are irrigation systems throughout the state that are in poor condition. Because irrigated agriculture is of significant value to the state economy, the Montana State Legislature has directed the DNRC to investigate the extent to which the State's irrigation systems require repair.

5.1 Overview

The inventory was conducted in two parts, a mail survey and on-site evaluations. The mail survey was intended to be an efficient way to gather information from a large number of irrigation system operators. The on-site evaluations were intended to "ground-truth" the mail surveys. This two-pronged approach seems to have been successful. The biggest hurdle was the fact that many of the operators are also farmers and ranchers and they are very busy people. Relatively few of the State's water supply organizations have full time employees whose sole responsibility is operation and/or management of the system or company. However, there was a general willingness to be involved on the part of most of the entities that were contacted. Responses were received from approximately 35% of the recipients. There was a good variety of system types and sizes among the respondents. We believe the response rate provides a good sample for analysis.

5.2 Mail Survey Methods

A detailed survey questionnaire was developed with input from water resource specialists, engineers and DNRC personnel. A copy of the survey is included in Appendix A. The survey was developed to present the questions in such a manner as to reduce subjectivity in the answers. For example, instead of asking the respondent to simply classify the condition of their diversion structure, we asked if the initial diversion was operating at less than 100% of its capacity. As a follow up to that question, the respondents were asked to categorize the current operating capacity of the diversion into one of the following categories; 0-25%, 25-50%, 50-75% and 75-99%. Similarly, respondents were asked to categorize the percentage of water lost through the conveyance system and asked if losses could be contributed to particular deficiencies in the system such as damaged lining, excessive vegetation, pipeline leakages, etc.

The survey was sent out to 229 recipients based on a list supplied by the DNRC. The total list contained 246 irrigation water supply organizations, 20 State Water Project related water users associations and seventeen US Bureau of Reclamation Irrigation districts. (Lists of recipients and respondents are included in Appendix B). This list contains most of the water supply organizations that are known to the DNRC personnel. Staff members of the eight Water Resources Division Regional Offices were instrumental in developing the list. The list was checked against the State Engineer's Water Resources Survey records to determine the number of and name of the ditches used by each organization. Secondly, the list was spot checked against the Secretary of State's business listing to determine if the organization was a legally incorporated entity and if any updated name and address information could be obtained. Records were also cross-referenced with the DNRC water rights database.

It should be noted that surveys were not sent to SWP water users associations or to all of the USBR projects because a significant amount of information was already available about the condition of these systems from information provided to us by the SWP Bureau and the USBR.

Operators of very large and complex systems, e.g., those with more than three diversions and main canals, were sent an abbreviated version of the survey.

The final section of the questionnaire asked for cost estimate information. Three categories of projects were included. The first category referred to repair work that has recently been conducted, the second referred to work that is in the planning stages and the third category referred to future repairs that are required but not yet in the planning stages. Respondents were requested to classify the cost of the first and second categories into four ranges;

- $500 to $10,000
- $10,000 to $50,000
- $50,000 to $500,000
- over $500,000

These ranges were purposefully broad in order to get an idea of costs without causing respondents to feel obligated to provide detailed cost estimates. Although this method worked well on an individual basis, when the numbers were compiled for overall cost estimate purposes, the ranges proved to be overly broad. As a remedy for this situation, the cost estimates reported in the Results section list the low end of the range, the high end of the range and the middle of the range (calculated by subtracting the low from the high and dividing that number in half). The mid range was then used as the basis for comparison when estimating the contribution from various funding sources, federal, state, local or private.

5.3 Survey Results

Surveys were sent to 229 of the total 246 irrigation water supply organizations and 81 responses were received for an overall response rate of 35%. Please refer to the maps in Appendix C (Separate Attachment) for geographic representations of some of these results. Some parts of the survey were not applicable to some organizations. For example, the only infrastructure maintained by some entities is a storage facility and private individuals are responsible for their own diversion structures and ditches. In such cases, respondents completed only Parts D & E of the survey. Therefore, the number of respondents to individual questions varies.

As the responses were being compiled, several questions were identified as being the most pressing: How many respondents identified notable impairments in their diversion structures, conveyance systems and storage facilities? Of those that reported problems, what was the nature of the problem? How much money have the respondents spent on repairs in the recent past and how much do they expect to spend in the near future? What is the source of funding that they have received or expect to receive?

5.3.1 Part A of the Questionnaire

Part A of the Questionnaire asked about initial diversion structures. Seventy-five of the total respondents completed Part A. One of the questions in Part A of the survey asked the respondents to characterize the age of their initial diversion structure. Age of an irrigation structure is a key factor when assessing its overall condition and functionality. Respondents were asked when the initial

Effective Age of Initial Diversion	Percent of Total
0-10 years	11%
10-50 years	53%
More than 50 years	37%

***Table 10**. Percentage of Total Responses in Each Age Range Category.*

diversion structure was installed or last repaired or replaced. Three ranges were given;

- 0-10 years ago
- 10-50 years ago
- More than 50 years ago

Information was requested about repairs and/or replacement in order to better classify the "effective" age of the structure. A headgate or diversion dam may have originally been installed 90 years ago but if it has recently undergone significant repairs or replacement, then its effective age should be characterized as less than its overall age.

Table 10 gives the percentage of each of the age ranges identified by the respondents regarding their initial diversion structure. Figure 5 is a map depicting the approximate location of the survey respondents' initial diversions categorized into the three age ranges.

Another key question asked in Part A regarded whether or not the initial diversion structure was operating at less than 100% due to notable impairments. A follow up to this question was to indicate the cause of impairment, if one exists. Impairments were classified into three types,

- Worn out or damaged (faulty) components
- Channel migration/degradation/sediment accumulation (channel changes)
- Other

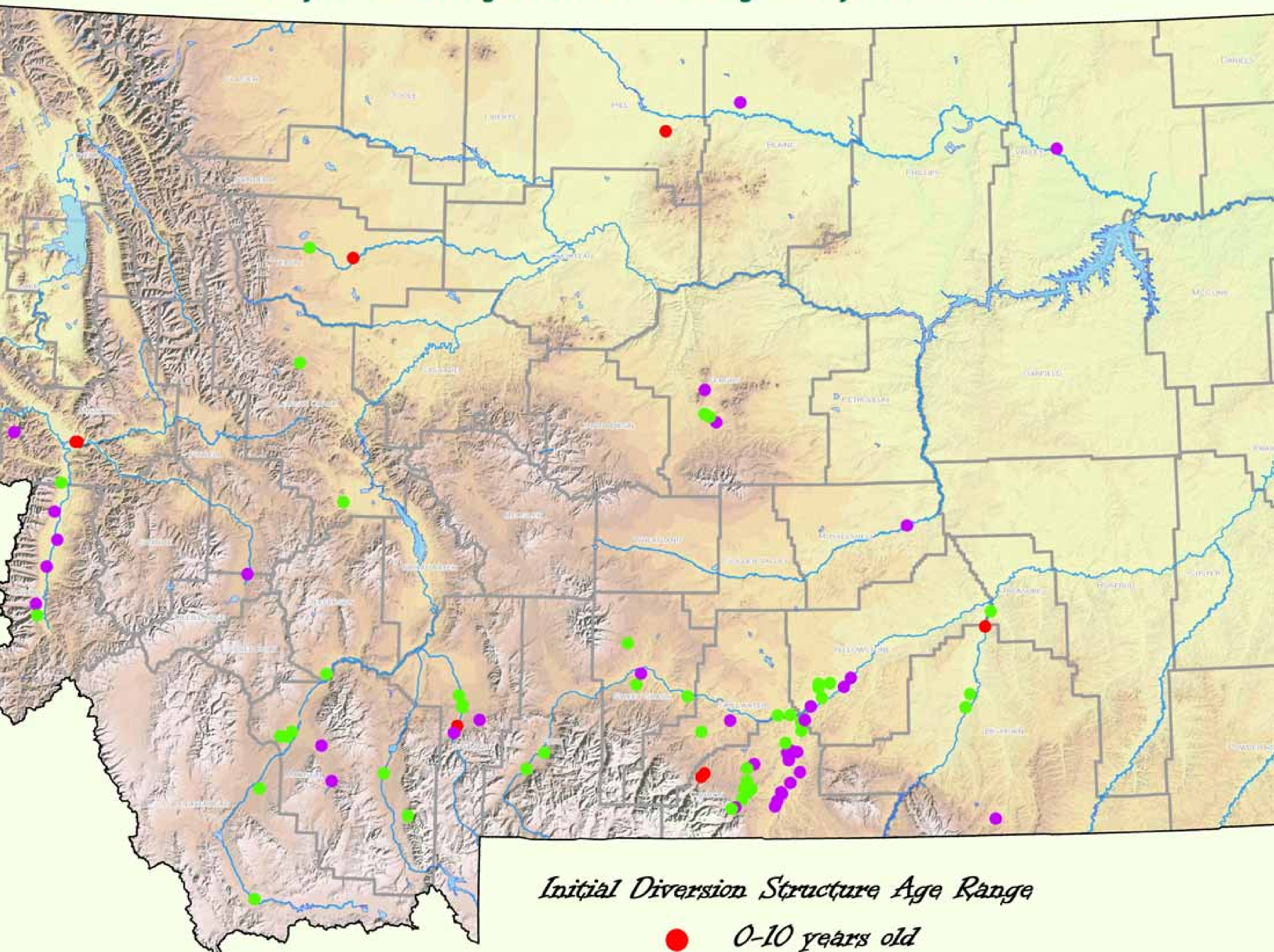
Type of Impairment	Percent
Faulty components only	50%
Channel changes only	21%
Both components & channel changes	25%
Other	4%

Table 11. *Percentage of Noted Impairments in Each of the Four Categories Listed on the Survey.*

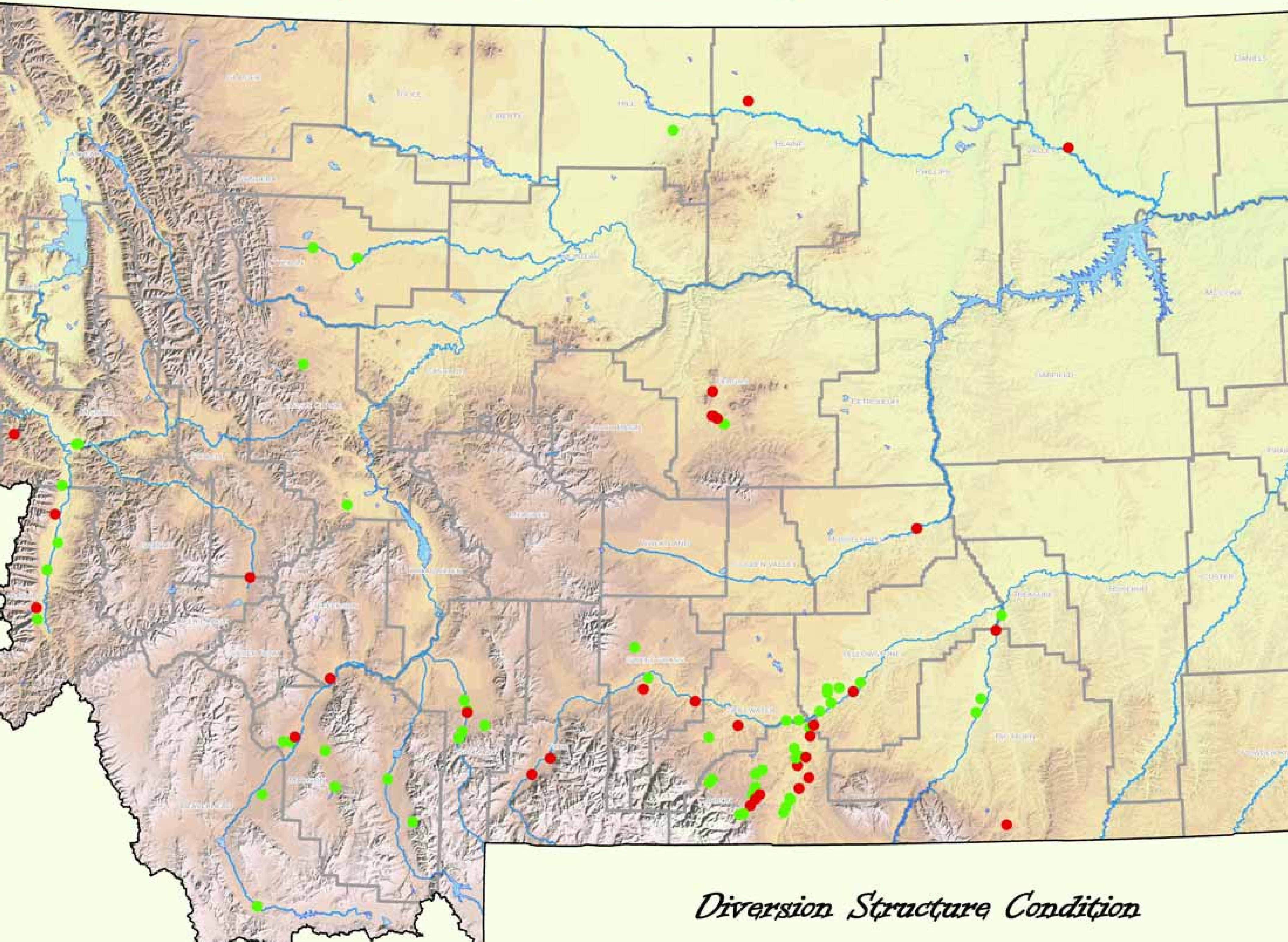
Of the 75 respondents who completed Part A, 24, or 32%, reported notable impairments. Some respondents indicated that they had a problem in just one category and some noted that they had trouble with both faulty components and channel changes. Table 11 shows the percentage for each impairment category for the twenty-four respondents who indicated that the initial diversion structure is impaired. Figure 6 is a map depicting the approximate location of the survey respondents' initial diversions categorized as "Impaired" or "Not Impaired" based on the information provided by the respondent.

More than half (58%) of the respondents who reported impairments characterized their diversion structure as more than fifty years old.

Reported by Mail Survey Respondents



Reported by Mail Survey Respondents



Diversion Structure Condition

5.3.2 Part B of the Questionnaire

Part B of the questionnaire asked about secondary diversion structures, i.e. those that are located down ditch from the initial source of supply. A typical example of a secondary diversion is a system in which a diversion dam in the river directs flow down a channel or ditch to some type of control structure, such as a headgate, where the operator can control the amount of water entering the system. Often the control structure includes some type of wasteway where excess water can be returned to the source.

Category	Percent
Systems with Secondary Diversions	57%
Impaired Structures	31%
Impaired Structures more than 50 yrs old	23%

Table 12. *Percentage of respondents indicating that the system includes a secondary diversion, percentage of secondary diversions identified as impaired and the percentage of impaired secondary diversion structures estimated to be more than 50 years old.*

Forty-two respondents identified that their system included a secondary diversion structure. Thirty-one percent of those reported impairments. In the case of secondary diversion structures, most (69%) of those reporting impairment characterized the age of the structure as being between ten and fifty years old. Table 12 summarizes a few statistics from the Part B Responses.

5.3.3 Part C of the Questionnaire

Part C of the questionnaire asked about the conveyance system; this would include ditches, canals pipelines, siphons, culverts, flumes, etc. Seventy-two respondents completed this section of the questionnaire. In this part, the respondents were asked if their conveyance system was operating at less than 100% capacity due to notable impairments. Forty percent of respondents indicated that one or more parts of their conveyance system were impaired. Table 13 lists the most common causes of impairment reported and the percentage of respondents that identified each type. The total percentage adds up to more than 100% as respondents were allowed to identify more than one type of impairment.

Type of Impairment	Percent
Areas of porous substrate materials	66%
Overgrown vegetation	62%
Sloughing of upslope material in ditch	31%
Leaks in above ground pipeline, siphon or flume	17%
Damaged concrete	10%
Poor ditch grading	10%
Leaks in buried pipelines	7%
Worn out or damaged lining	3%

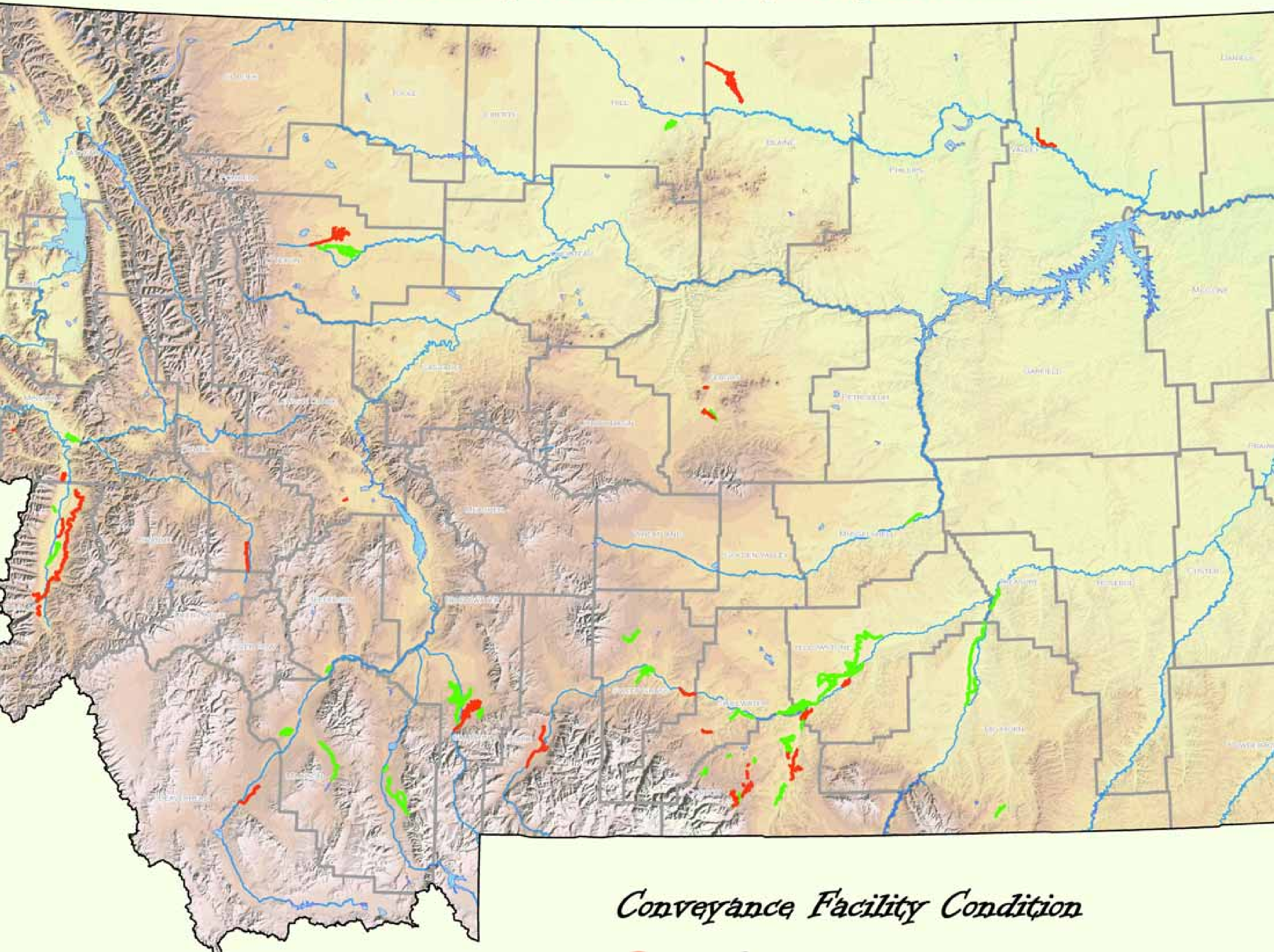
Table 13. *Percent of Types of Conveyance System Impairments Reported by Survey Respondents.*

Part C also asked if any components of the conveyance facility currently need to be replaced or will need to be replaced within the next five years. Twenty-one respondents reported that one or more components will need to be replaced now or in the near future. Table 14 lists the irrigation system component types provided on the questionnaire and the percentage of responses that identified each component type as being in need of repair or replacement. The total is greater than 100% because respondents were allowed to choose more than one component type. Figure 7 is a map depicting the approximate location of the survey respondents' conveyance facilities and categorizes them as "Impaired" or "Not Impaired" based on the information provided by the respondent. Siphons were the items most commonly identified as needing work, followed by ditches.

Component Type	Percent
Siphon	24%
Ditch	19%
Lining	14%
Pipeline	14%
Flume	14%
Turnout	14%
Drop box	10%
Pump or pumping plant	5%

Table 14. *Percent of Irrigation System Component Types Identified by Survey Respondents as Needing Repair or Replacement.*

Reported by Mail Survey Respondents



5.3.4 Part D of the Questionnaire

Part D of the questionnaire asked about storage facilities. Fifteen of the respondents reported storage facilities as part of their system. Seven respondents indicated that the stored water made up 75% or more of their total water supply. Four of those reported that their storage facility was impaired in some way.

5.3.5 Part E of the Questionnaire

Part E of the questionnaire had two main components. First, respondents were asked about the amount of money that they had spent within the last ten years on infrastructure repairs. Secondly, they were asked to estimate the amount of money needed for future repairs for projects that were either already in the planning stages, or that they knew were going to be necessary in the next five years. As discussed in the methods section above, respondents were asked to categorize cost estimates within one of four ranges;

- $500 to $10,000
- $10,000 to $50,000
- $50,000 to $500,000
- over $500,000

The respondents were also asked to identify the source of funding for recently completed project as either federal, state, local or private. They were also asked to project the funding sources for projects that need to be completed in the next five years. When multiple sources were identified, it was assumed that the costs was or would be split evenly among the sources. It is understood that this approach is somewhat arbitrary but based on the limited data available and the scope of the project, this method was deemed to be appropriate.

The questionnaire listed eleven different types of irrigation system components. In the tables below, these eleven types of components were grouped into three categories, diversion structures, conveyance facilities and a group for storage facilities and "other" system components.

The cost estimate results listed in the tables below report the low end of the range, the high end of the range and the middle of the range (calculated by subtracting the low from the high and dividing that number in half). The "over $500,000" category was interpreted to be a range between $500,000 and $5 million. Table 15 lists the low, high and mid-range cost estimates for projects recently completed by the survey respondents.

	Low	High	Mid
Diversion Structures	$390,000	$3,100,000	$1,355,000
Conveyance Facilities	$541,500	$4,880,000	$2,169,250
Storage and Other	$411,000	$4,070,000	$1,829,500
Inventory Totals	**$1,342,500**	**$12,050,000**	**$5,353,750**

Table 15. *Low, High and Mid Range of Cost Estimates Reported by Survey Respondents for Recently Completed Projects Grouped by Irrigation System Component Category.*

Table 16 identifies the percentage and amount of each funding source that is estimated to have contributed to the recently completed projects. The percentage was derived by comparing the total portion attributed to each funding source with the mid-range cost estimate values listed in Table 15. These percentages should be considered as broad generalizations not exact figures. The intent was to gain a general understanding of how projects are being funded.

	Private %	Private$	Federal %	Federal$	State %	State$	Local %	Local$
Diversion Structures	71%	$957,600	14%	$189,100	9%	$127,250	6%	$76,100
Conveyance Facilities	43%	$923,625	41%	$894,950	10%	$212,325	6%	$135,700
Storage and Other	45%	$814,750	12%	$222,750	35%	$634,500	8%	$148,500
Inventory Totals	**50%**	**$2,695,975**	**24%**	**$1,306,800**	**18%**	**$974,075**	**7%**	**$360,300**

Table 16. *The Percent and Estimated Amount of Money from Each Funding Source Category Spent on Projects Recently Completed by Survey Respondents.*

Tables 17 and 18 present the same information for future projects that Tables 15 and 16 presented for recently completed projects. The funding source information is even more generalized because several survey respondents did not identify the expected source of funding. In these cases, it was estimated that funding would be split evenly among federal, state and private sources.

	Low	High	Mid
Diversion Structures	$1,535,500	$14,760,000	$6,612,250
Conveyance Facilities	$1,947,000	$18,590,000	$8,321,500
Storage and Other	$2,270,500	$22,610,000	$10,169,750
Inventory Totals	**$5,753,000**	**$55,960,000**	**$25,103,500**

Table 17. *Low, High and Mid Range of Survey Respondent Cost Estimates for Future Projects Grouped by Irrigation System Component Category.*

	Private %	Private$	Federal %	Federal$	State %	State$	Local %	Local$
Diversion Structures	36%	$2,353,018	31%	$2,049,518	31%	$2,039,518	2%	$105,818
Conveyance Facilities	26%	$2,174,503	40%	$3,306,503	32%	$2,651,503	2%	$146,750
Storage and Other	40%	$4,088,250	23%	$2,376,000	36%	$3,623,500	0%	$10,000
Inventory Totals	**34%**	**$8,615,770**	**31%**	**$7,732,020**	**33%**	**$8,314,520**	**1%**	**$262,568**

Table 18. *The Percent and Estimated Amount of Money from Each Funding Source Category Expected to be Spent on Future Projects as Reported by Survey Respondents.*

5.4 Mail Survey Discussion and Conclusions

The quality of the responses to the mail survey was variable. The survey form was printed on both sides of the paper and in several instances it appeared that the respondent neglected to fill out the backside of a page. It was apparent in some responses that some questions were misunderstood. Overall though, good information was obtained. One item of note was that very few surveys were returned as undeliverable. This indicates that the contact information that was relied upon is good.

When the survey was developed, it seemed pertinent to know about the composition of the irrigation systems, e.g. the type of materials in the diversion structures, but this information is probably less important than it originally seemed because while a large amount of data were generated, it did not help identify infrastructure problems. The questions regarding the performance of the system components were more to the point of this study.

A total of 81 irrigation water supply organizations responded to the survey from a list of 246. Mail surveys were not generally sent to the USBR and SWP projects (with one minor exception, Fort Shaw Irrigation District did receive a survey and responded). Only one Bureau of Indian Affairs project, the Fort Peck Water User's, responded. Therefore, the irrigation water supply organizations involved in the survey can generally be characterized as non-government related systems. The survey data will be compiled with information from the summary of existing information section of this report to arrive at some statewide estimates.

The survey respondents included systems from a wide variety of locations across the state, providing a good geographic representation. In addition, various sized systems were included among the survey results. Information was received from both small systems that serve only a few hundred acres or less and from large systems that serve 10,000 acres or more. The sample seems to be a good representation of irrigation systems across the state.

Before drawing any statewide conclusions, a few assumptions must be made. First, it is assumed that the list of 246 irrigation water supply organizations represents all such organizations in the state. Secondly, the figure reported by the National Agricultural Statistics Service that 60% of the irrigated acres in Montana receive irrigation water from an irrigation water supply organization is assumed to be accurate. It is assumed that this figure is appropriate to use as a means to estimate the total amount of infrastructure across the state. This third assumption is based on the concept that there is a correlation between the number of irrigated acres and the amount of infrastructure required for a given system. Finally, it is assumed that the survey results are a representative sample of Montana's irrigation water supply organizations. The conclusion reached as a result of these assumptions is that the survey responses account for 19% of all the irrigation systems in the state and that this percentage can be utilized to extrapolate the survey results to statewide conditions.

32% (% of water supply organizations that responded)	of	**60%** (% of systems statewide operated by water supply organizations)	=	**19%**

Table 19 lists the types of structures that were inquired about in the survey questionnaire along with the number and percentage of respondents that indicated impairments in each of these categories. These numbers can be used to extrapolate the number of systems statewide that are experiencing similar impairments. Table 20 lists the statewide number of structures in each category estimated to be impaired. This estimate was arrived at by dividing the number of survey respondents in each category that reported impairments by 19%. This provides a general idea of the number of structures or facilities that are in need of repair.

Structure Type	Respondents Reporting Impairment	
	Number	Percent
Diversion Structures	37	32%
Conveyance Facilities	29	40%
Storage Facilities	8	53%

Table 19. *Percent of Respondents Reporting Impairments for Each Irrigation System Structure Type Category.*

The cost information provided by the survey respondents can be used to estimate costs associated with needed repairs. The mid-range cost estimate for future projects from Table 18 above indicates that $6.6 million is needed for repair of diversion structures for the survey respondents. On average, this equates to approximately $179,000 for each of the thirty-seven systems that indicated impairment in the diversion structure. If this is applied to the 194 diversion structures estimated to be impaired statewide, the result is $34.7 million needed to repair diversion structures statewide. Using this method, the costs associated with repairing all three structure types statewide can be estimated. The total estimated statewide cost to repair all non-government systems is $131.1 million.

Structure Type	Statewide Estimated Number of Impaired Structures	Estimated Average Cost per Structure	Statewide Estimated Cost for Structure Type
Diversion Structures	194	$179,000	$34,700,000
Conveyance Facilities	152	$286,000	$43,500,000
Storage Facilities	42	$1,260,000	$52,900,000
		Total	**$131,100,000**

Table 20. *Estimated Number of Impaired Structures Statewide by Structure Type Category, Estimated Average Repair Cost per Structure and Statewide Estimated Repair Cost for All Impaired Structures Statewide.*

5.5 On-site Evaluation Methods

Several different methods were considered for selecting the systems for the detailed site evaluations. It was decided that given the variety of systems across the State, a geographic sampling would be most beneficial for informational purposes. An effort was made to contact several water supply organizations in several different parts of the state. Some organizations that we contacted declined our request for a site evaluation. In most cases, this was because the operators were themselves farmers and taking the time to give our inspector a tour of their system would be a hardship. Thus, the sites that were physically inspected were initially chosen with an effort towards a geographic distribution but were ultimately determined by willingness and ability of operators to participate.

During the course of planning for the on-site evaluations, it was determined that the same questionnaire used for the mail survey would be appropriate for the on-site evaluations. The inspector completed the questionnaire during the site visit and supplemented this with more in-depth estimates of costs for needed repairs. The results of the on-site evaluations were compiled with the mail survey results.

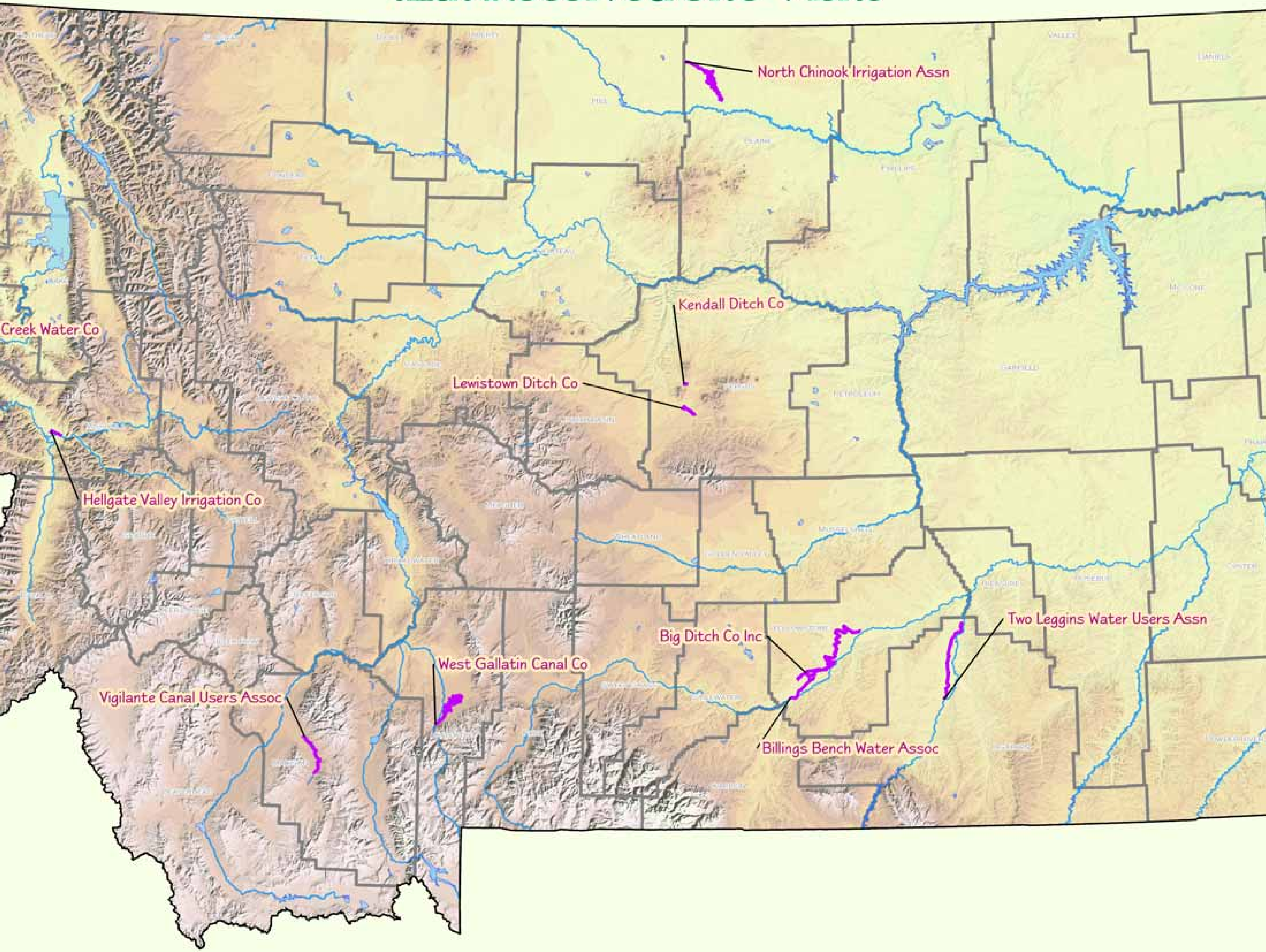
5.6 On-site Evaluation Results

On-site evaluations were conducted on ten systems: See Figure 8 for a map depicting the locations of these systems.

- Big Ditch Company – Billings, MT
- Billings Bench Water Association – Billings, MT
- Hellgate Valley Ditch Co. Missoula, MT
- Ed's Creek Water Company – Huson, MT
- Kendall Ditch Company – Lewistown, MT
- Lewistown Ditch Company – Lewistown, MT
- North Chinook Irrigation Association – Chinook , MT
- Two Leggins Canal Company – Hardin , MT
- West Gallatin Ditch Company – Gallatin Gateway, MT
- Vigilante Canal Company – Sheridan, MT

The evaluations did reveal some problems. Following is a description of each system that was visited.

that Received Site Visits



5.7 Big Ditch Company, Billings, MT

This system was inspected on September 17, 2008. Evaluation was conducted by Lance Lehigh of PBS&J and Russ Cumin, Big Ditch Superintendent and water user.

5.7.1 Diversion and Control Structure

The Big Ditch Company of Billings Montana diverts water from the Yellowstone River. The company's diversion dam runs from north to south across the river and is built out of concrete. The diversion appears to be in good working order and is in no need of repair. During yearly runoff events, large trees and debris sometimes get hung up on the diversion dam but only on rare occasions. The annual maintenance performed on this structure is minimal.

Big Ditch Diversion Dam on the Yellowstone River

The headgate control structure consists of six large metal slide gates. In order to open and control these gates a hand driven crank or a vehicle motor is used. According to Russ, the system works well and does not cause many problems. The overall structural integrity of the concrete is good and there was no apparent cracking. Large woody debris occasionally interferes with the head gates. The ditch operator then has to use a backhoe to remove the objects, which costs time and money.

In front of the headgate structure is a makeshift trashrack intended to deflect logs and other debris away from the headgate control structure. According to the superintendent, the system works adequately during high flows and the trashrack keeps most debris away from the headgate structure. However, the trashrack appears to be in bad condition and needs to be replaced in some sections. For example, the concrete piers are cracking and the middle support is almost destroyed. The wooden planks used to access the structure are in need of replacement and not structurally sound. Several steel pipes are rusted out and no longer effective.

Another major issue associated with the initial diversion is the channel itself. There is no problem getting sufficient amounts of water to the headgates and into the ditch during high flows. However, during low flows, the diversion does not direct enough water into the channel. Russ and other ditch operators have to enter the channel and essentially create a new one to direct flow towards the headgates. This has been an on going issue and creates unwanted work.

Trashrack in Front of Big Ditch Headgate

5.7.2 Secondary Control Point

The ditch's secondary control point is located in the area of 72nd and King. There is a small spillway that was built to channel excess flow into Canyon Creek and is operated by placing boards in slots to raise the overall height of the ditch. This seems to be an effective way to control the water level and is relatively maintenance free. There are a total of four slide gates in the main channel of the ditch that allow water to be conveyed through the system. These slide gates and the overall control structures are in good condition. The structure itself was built in 1945.

A siphon is located downstream from the secondary control structure. The siphon directs the ditch directly under Canyon Creek and reappears at the same elevation about 500 yards away. The system works well but trash and other debris tend to choke the system. In addition to other maintenance duties, the ditch operators must clean this area after any major wind event.

5.7.3 Snow Ditch and Diversion at 48th and Grand Ave.

The Snow Ditch is a small ditch that branches off the main Big Ditch channel. The Snow Ditch supplies water to agricultural and residential areas along Shiloh Road. The only problems associated with the Snow Ditch are the large amounts of trash and grass clippings dumped into the canal. The ditch operator uses boards to control the amount of water that enters into the Snow Ditch. Although crude, this method seems to work well.

5.7.4 Shiloh Walking Path Problems

By the time the Big Ditch reaches Shiloh Road, it is small enough to jump across or wade through. Russ has had some serious issues in this area. People do not mow the side of the banks, which causes the water velocity to decrease throughout the system. This causes sediments and other fines to clog and choke out the system. In addition, a culvert that was installed underneath Shiloh Road was not properly sized and is now an issue for the Big Ditch Company. The culvert needs to be replaced with a proper functioning one.

5.7.5 Four Drop Points

The four drop points on the Big Ditch system are all similar. These structures are used to dissipate energy as water drops from a higher elevation to a lower one. All four of the drops are made of concrete and are in very good condition. Some of the drops have been recently upgraded or fixed. Overall, these structures are functioning properly and in good condition.

Laurel Drop Structure

5.7.6 Siphon at Park City

The siphon at Park City is used to convey the ditch under a small stream. The siphon only runs about 100-200 yards in total distance. Overall, this system functions well but is in some need of concrete repair. Along the side walls, pieces of sandstone and other materials have been falling into the ditch. These objects flow into the siphon and have to be removed at the end of the year. Only a small amount of maintenance is required here but new walls would reduce maintenance even further.

5.7.7 Benner's Check

This is a point in the ditch where boards are placed to create a backwater effect. The backwater effect is used to fill a distribution ditch. This is a crude system and could be upgraded for better control.

Benner's Check structure used to get water into distribution ditch headgate that can be seen in foreground of the photo.

5.8 Billings Bench Water Association, Billings, MT

This system was inspected on September 16, 2008. Evaluation was conducted by Lance Lehigh of PBS&J and Glenn Downer, Ditch Superintendent.

5.8.1 Diversion and Control Structure

The Billings Bench Water Association diverts water from the Yellowstone River. There is no diversion dam across the Yellowstone River for this diversion. The control structure has been placed so that the river easily feeds into the system with out the need for a diversion dam. Glenn Downer said maintenance has been very minimal at the site and that the system works well overall. During yearly runoff events, large logs and debris sometimes clog the head of the system. Easier backhoe access would facilitate maintenance at this site.

The headgate control structure consists of four large metal slide gates. A hand crank is used to open and control the gates. This system seems to work adequately as long as the gates are only being moved less than one foot at a time. During the beginning and end of the season, a small truck is used to open and close the gates. This requires the ditch operators to remove the wheel of the truck and use the crank shaft to open and close the gates. During emergencies, the amount of time required to operate the gates is a safety issue. An upgrade of the gate control mechanism would be advisable.

Billings Bench Headgate

There is no apparent deterioration of concrete in the headgate structure. Overall, the initial takeout point is in good condition but could use some updating on certain components.

5.8.2 Large Wooden Flume (Secondary Control point)

A large wooden flume is used to convey the ditch across Canyon Creek which is on Billings West end. The structure was built in the 1940's and according to the ditch operators works rather well. There are a total of four head gates located in the middle of the flume. These head gates help control the level of the ditch. However, even with all four of the head gates open, the water level in the ditch is not adequately reduced. This has been a cause for concern in case of an emergency. The only way to shut off the ditch completely is at the initial diversion.

Canyon Creek Flume

The overall structural integrity of the flume looks good. The large concrete piers that carry the load were intact and the frame was in good condition. The walking deck and planks need to be replaced and a structural assessment would be beneficial. A staff gauge directly downstream of the flume allows the ditch operators to judge the flow in the system at this location. However, the staff gauge has not been calibrated for a number of years.

5.8.3 Tunnel Through the Rims

A tunnel directs the ditch through the rims over into the Alkali Creek area. The tunnel is in very good condition and does not pose in major issues. There have been reports of people falling into the ditch and being taken through the tunnel to the other side. Safety measures could certainly be improved in this location.

5.8.4 Siphon Entrance

About half a mile downstream from the tunnel, the ditch enters a large siphon. The siphon directs the ditch underneath several roadways and Alkali Creek. The ditch re-surfaces at the same elevation it entered on the other side of the valley. The siphon works rather well and there have been no major issues with the system. Again, safety in this type of area needs to be increased. There is no fencing or any hazard signs. There were several balls and toys floating in the area in front of the siphon entrance, leading one to be concerned about children playing in the area. Again, safety improvements should be considered.

5.8.5 Rattlesnake Lake (Storage)

Rattlesnake Lake is a large lake that is used for irrigation and hunting purposes. The area itself is rather undeveloped. The lake and associated infrastructure are in good condition.

5.8.6 Ditch Exit

The Billings Bench Canal terminates at a small coulee east of Shepherd. At this point, the ditch flows about five cubic feet per second (cfs) compared to the approximately 500 cfs that is originally diverted out of the Yellowstone. A few structural issues in this area could use some attention. For example, the large concrete spillway that helps direct the out-flow down into the coulee has collapsed and needs replacing in order to reduce erosion issues.


End of the Billings Bench Canal

5.9 Ed's Creek Water Company Pipeline, Huson, MT
This system was inspected on October 30, 2008. Evaluation was conducted by Julie Merritt of PBS&J and Robert Anderson, Ed's Creek Water Company President.

5.9.1 Diversion and Control Structure
The Ed's Creek Water Company diverts water out of Ed's Creek approximately seven miles south of Alberton in western Missoula County. It is a small system that irrigates about 100 acres. The diversion structure is a concrete box constructed across the stream channel. The box functions to raise the water level high enough to fill an 8-inch pipeline. The concrete structure is badly deteriorated.


Ed's Creek Diversion Structure

The concrete box is divided in half by a screen to prevent debris from entering the pipeline. The users have placed boards along the stream channel to keep the water flow directed toward the concrete diversion structure. This diversion system is very make-shift and is not likely to last much longer.

5.9.2 Pipeline
An 8-inch buried pipeline runs from the diversion point down the drainage; a distance of approximately one mile. Users along this length have individual risers off the line. Some households use this water for domestic purposes and others use it for small-scale

irrigation and stock watering. The main users are located at the bottom of the drainage. Here the mainline splits and runs a short distance south and north. Three property owners irrigate approximately 80 acres. There is sufficient pressure in the system to run 100 or more sprinkler heads.

The pipeline occasionally develops leaks, requiring excavation and replacement of the damaged section.

5.10 Hellgate Valley Irrigation Company Canal

This system was inspected on September 30, 2008. Evaluation was conducted by Julie Merritt of PBS&J and Harvey Clouse, Ditch Co. Secretary:

5.10.1 Diversion and Control Structure

The Hellgate Valley Canal diverts water from the Clark Fork River near downtown Missoula. The company's diversion dam is comprised of rock rip-rap that runs closely parallel to the direction of flow creating a channel on the north side of the river directing water towards the flow control structure.

Hellgate Valley Canal Diversion Dam

The flow control structure is a concrete structure with one large metal slidegate. Adjacent to the flow control structure is a concrete and metal wasteway that allows excess flow to return to the river. The canal operator can install wooden planks in the wasteway to decrease the amount of water that is returned to the river thereby increasing the flow into the canal.

The rock diversion dam requires maintenance every three-five years for which the company is required to obtain a 310 permit. The company recently spent approximately $2,000 to re-construct the rip-rap diversion dam. The flow control structure and the wasteway are in good condition.

5.10.2 Urban Structures

Urban encroachment has had a big impact on the Hellgate Valley Irrigation Co. Large sections of what was once open ditch have been replaced by buried pipelines. A few hundred yards down from the control structure, a culvert takes the ditch under California

Street. The ditch is open for a short stretch then goes into another culvert at the corner of Russell St and Broadway. From there, the ditch was replaced by a pipeline that extends approximately 0.4 to 0.5 of a mile along Broadway and through the intersection of Broadway and Mullan Road.

The ditch becomes as an open ditch along Mullan Road until it is piped under the intersection of Mullan and Reserve. On the west side of this intersection, it returns to the surface and is an open ditch for the remainder of its length.

5.10.3 Suburban Structures

The majority of the acres served by this ditch are west of town. There are four main agricultural users irrigating a total of approximately 400 acres. The only maintenance problem reported in this area has been ground squirrels causing excess seepage in an area near a subdivision. Some flooding was attributed to this but cleaning and maintenance on the ditch appear to have controlled this problem. The ditch eventually dumps into Grant Creek several miles west of town

5.11 Kendall Ditch Company, Lewistown, MT

This system was inspected on September 17, 2008. Evaluation was conducted by Lance Lehigh of PBS&J and Jim Philips, Ditch Rider and water user

5.11.1 Diversion and Control Structure

The Kendall Ditch diverts water from Warm Spring Creek. The initial diversion consists of large boulder rip-rap diversion dam that extends about thirty feet out into the stream channel. The rip-rap is in poor condition. Large sections have been washed away reducing the amount of water flowing into the ditch. This also allows sediments and other debris to build up in the ditch channel.

The control structure consists of two culverts, both with 2-foot diameters. There are no gates on this structure so water is allowed to flow into the system without check. Furthermore, a small beaver population chokes the channel with debris and plugs the culverts on a regular basis

Culvert Under the Intersection of Mullan Road and Reserve Street

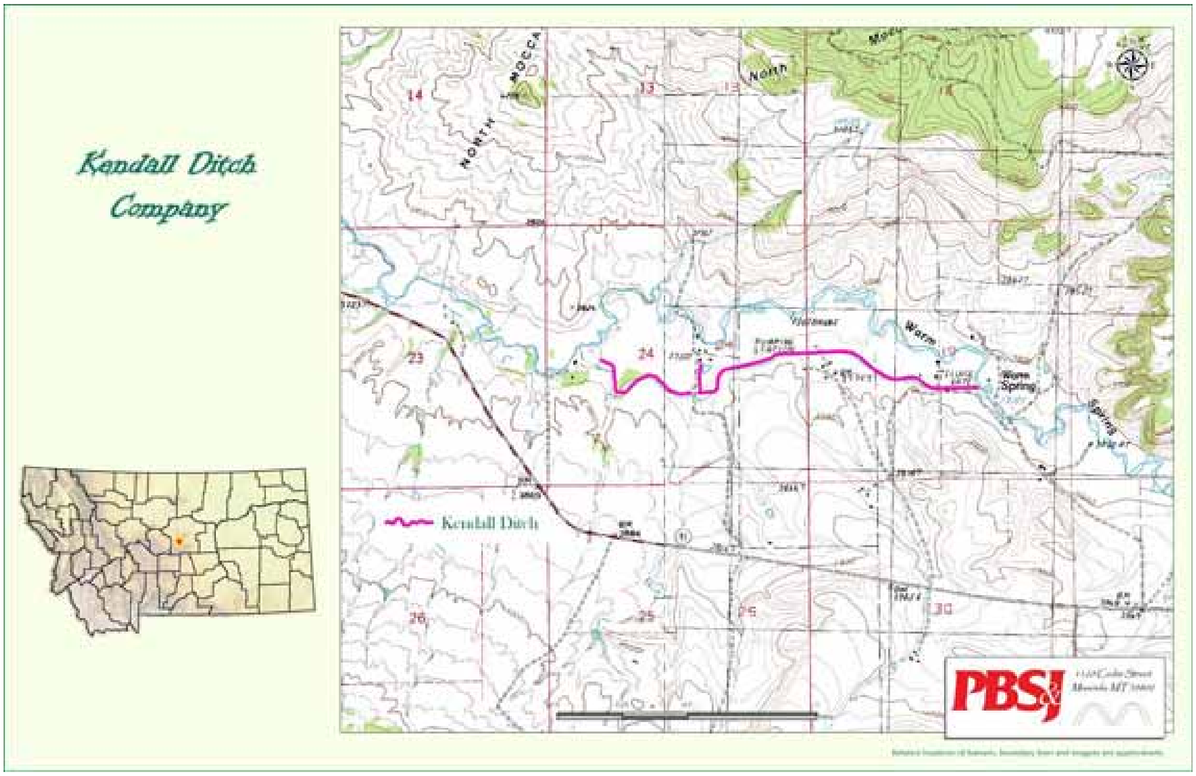


Figure 9. *Kendal Ditch Company Location.*

Kendall Ditch diversion dam - ditch channel is on the right side of the photo.

5.11.2 Crossing Nearest to Diversion

The crossing nearest to the diversion allows local residents access to their property. The crossing consists of two 2-foot diameter culverts and a deck roadway. The concrete that holds the culverts in place is cracking and could pose structural issues in the future. Also, the culverts must be cleaned out on a monthly basis due to the local beaver population. This problem could be fixed by installing a bridge which would reduce the amount of debris that builds up in this location and would allow better flow through the system.

5.11.3 Bridge at Jim Phillips' Property 1

The bridge at Jim Phillips' property allows access to his property to the east of the canal. The bridge was installed about five years ago. It has reduced the level of maintenance required at this location. It allows adequate flow through the system and is easy to clean.

5.11.4 Active Pump Station
There is a small pump in the canal that Jim Phillips uses to irrigate his crops. It has been relatively maintenance free.

5.11.5 Slope Stabilization Problems
As the ditch makes a bend near the Jim Phillips' home site there have been several issues with bank erosion and slope stabilization. Jim has had to take fill from his property and reinforce the bend facing his home. In case of a major storm event the ditch bank could possibly collapse causing major flooding on the property.

5.11.6 Home Site Access Crossing
One issue the ditch company faces is beaver activity. During the site evaluation, one bridge crossing was observed that is consistently clogged by beavers. The flow in the channel stops at this point and is considered a major choke point on the systems. Down the ditch from this point, there is little flow through the channel and the pump below this point cannot operate due to the low flows. To the east, the channel is backed up and flow is at a stand still. The crossing consists of two 2-foot diameter culverts and a fill in road deck on top.

5.11.7 Main Pumping System
The pump site is located about ¼ mile west of Jim Philips. The pump, motor and pipeline are in good condition but cannot run when the flow in the ditch is too low.


Pump Station – not operating due to low flows.

5.11.8 Storage Pond near Home Site
There is a small storage pond on Jim Phillips' property that is filled from the ditch. Mr. Phillips irrigates out of this pond and uses it to water livestock. The pond and the headgate that serves it are in good condition. Again, beaver activity chokes the channel and requires routine maintenance to keep everything running properly.

5.11.9 Ditch Exit
There is some erosion at the ditch exit that needs to be controlled.

5.12 Lewistown Ditch Company, Lewistown, MT
This system was inspected on September 15, 2008. Evaluation was conducted by Lance Lehigh of PBS&J and Dan Stilson, Ditch Rider and water user.

5.12.1 Diversion and Control Structure

The Lewistown ditch diverts water from Big Spring Creek. There is no diversion dam in the stream channel to direct flow towards the headgate but the location of the headgate allows for proper flow into the system. The channel consists of river rock and cobble. There are fine sediments in the system but the overall turbidity is low.

The headgate control structure is a metal screw gate in a wooden housing. The overall structural stability of the system is round. The concrete and foundation of the structure is in good condition and the rip-rap protecting the area is adequate to handle large flow events. A large log was placed in front of the headgate structure to prevent debris from entering the ditch. Maintenance on this site is low and the functionality of the system is good.

5.12.2 Culvert under Highway 191

Below the initial diversion, the ditch flows to the northwest and crosses under Highway 191. The culvert under the highway has buckled and no longer passes adequate flows. This causes a backwater effect and reduces the system capacity. In addition, trash and other debris pile up at the entrance and cause routine maintenance problems at the site. In order to fix the problem the existing culvert would need to be removed and replaced.

5.12.3 Urban/Suburban Encroachment Concerns

The ditch runs along Highway 191 and the ditch company is concerned that this road will be widened in the future to accommodate growth in this area. Expansion of the roadway would likely have an impact on the ditch and the ditch company is uncertain who would be responsible for ditch modifications necessary to accommodate an expanded roadway.

5.12.4 Trailer Park Seepage Issues

The ditch runs parallel to a local trailer park and there has been some controversy over seepage issues. Some residents have complained to the ditch company about flooding in the crawl spaces under their homes. If seepage from the ditch is the cause of the flooding problems, lining the section of the ditch adjacent to these residences may resolve the issue.

Ditch Running Parallel to Highway

5.12.5 Old Saw Mill Seepage and Erosion Issues

A sawmill located in close proximity to the ditch recently went out of business and has left some outstanding issues. Some material left at this site has raised environmental concerns. The ditch in this location is perched on the hillside above the defunct sawmill facility and Big Spring Creek is down-gradient from the sawmill site. There is concern that water seeping from the ditch through the site is causing water quality issues in Big Spring Creek.

Although the Lewistown Ditch Co. is not responsible for materials left at this site, they are perceived as part of the problem. Lining this stretch of the ditch might reduce the amount of water seeping through the site and into Big Spring Creek. In addition, this part of the ditch is perched about fifty feet above Big Spring Creek.

There are erosion issues and slide problems. The ditch company attempted to re-vegetate the area; however, these efforts have not been successful. More extensive slope stabilization techniques need to be applied along this reach.

5.12.6 Wolverine Creek Distribution Ditch

Wolverine Creek distribution ditch is one of the eleven distribution ditches on the Lewistown ditch network. All of the distribution ditches are in good working order. Each distribution ditch has a metal slide gate to control the flow.

5.12.7 Don Jennings Erosion Issues

Don Jennings is one of the users and operators of the Lewistown Ditch Company. He assists with the maintenance of the ditch. The tail end of the ditch flows through his property and dumps back into Big Spring Creek. There are several sites on his property where seepage and erosion has been an outstanding issue. In some areas the ditch bank has sheared off or is beginning to slide downhill. Don has had to haul dirt into these areas and re-establish the ditch banks.

5.12.8 Don Jenning's Pond

A small storage pond is used to feed two pivot irrigation systems on Don Jenning's property. This small pond is in good condition and does not require large amounts of maintenance.

Erosion Issues Along Ditch Bank

5.13 North Chinook Irrigation Association, Chinook, MT

This system was inspected on September 29, 2008. Evaluation was conducted by Lance Lehigh of PBS&J and Kevin Elias, Ditch Superintendent

5.13.1 Diversion and Control Structure

The North Chinook Canal diverts water from Lodge Creek to a large storage facility. The diversion is made of concrete and spans the width of the creek, about 75 to 100 feet. The diversion runs perpendicular to the flow and channels water towards a concrete control structure with three metal slide gates.

The diversion structure is in very poor condition. There are large cracks in the structure that allow water seepage and freezing to take place. Furthermore, a check structure adjacent to the dam no longer functions. This check was originally used to help divert water towards the headgate during low flows and to allow excess water to flow back into Lodge Creek during high flows. Overall, the system is in need of concrete repair, weed removal, and the replacement of the board check structure.

The headgate control structure is located east of the diversion and consists of three metal slide gates. The structure leaks and has severe structural damage due to the freeze-thaw process in the area. Beaver activity further reduces flows in the ditch channel and causes constant maintenance problems. During high flows, an adequate amount of water gets into the system however, once flows diminish, very little, if any, water gets in the ditch.

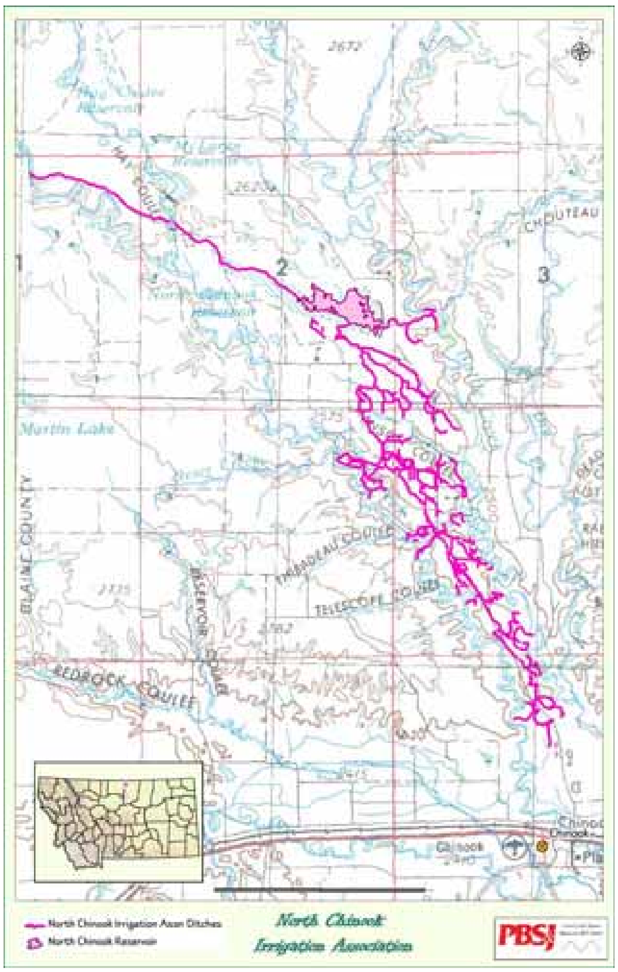


Figure 10. *North Chinook Ditch Location.*

The water that is diverted makes its way to a large storage facility that is located about six miles away. The channel in which the water travels is choked with willows and other weeds. This causes lower velocities to occur and hinders the overall irrigation process. Lining on this channel would be beneficial.

5.13.2 North Chinook Reservoir

The North Chinook Reservoir About is located about 6 miles down ditch from the initial diversion. This storage facility consists of dikes built up to hold water back from the adjacent farmland. It covers approximately 500 acres. This facility was created in 1915 and is the backbone of the system for several water users in the area. The facility and its related infrastructure are in good condition.

North Chinook Diversion Dam on Lodge Creek

The reservoir's main problem is that its extensive surface area causes large evaporation losses. On hot windy days, evaporation has been known to lower the reservoir level by several inches (approximately 200 acre-feet) in one day. The North Chinook Irrigation Association has placed several hundred feet of rip-rap along the northwest side of the dike system. This rip-rap is needed to protect the dike from erosion and to dissipate wind energy. The overall cost of the rip-rap application was approximately $10,000. Such costs are a large burden for these users.

A View of the Dike System

Headgate Structure within the Reservoir

5.13.3 Turnouts

There are a total of nine users on the North Chinook Irrigation Association system. Each user has a turnout. The turnouts on the system are in good condition and require little annual maintenance.

5.13.4 Vegetation Issues

One of the biggest problems along this ditch is overgrown vegetation. Lining the system would help prevent these problems and increase efficiency.

5.14 Two Leggins Ditch, Hardin, MT

This system was inspected on September 17, 2008. Evaluation was conducted by Lance Lehigh of PBS&J and Kevin Vandersloot, Ditch Rider

5.14.1 Diversion and Control Structure

The Two Leggins Ditch diverts water from the Big Horn River. The diversion dam is made of concrete and spans the width of the river which is several hundred feet. It runs perpendicular to the flow and channels water to the control structure located on the west bank of the river. It appears that the diversion is functioning properly and is allowing adequate flow to reach the main headgates. Kevin Vandersloot says he has not had any major issues with the diversion or the main control structure.

The headgate control structure consists of five large metal slide gates. The system seems to function well and has not had any major issues. Flow meters were installed on the headgate but are not currently functioning.

The concrete structure and the rip-rap adjacent to the headgate are in good overall condition. There are some minor cracking issues due to the freeze thaw cycle associated with a northern climate. However, large amounts of pond weed and moss choke the system and cause maintenance issues. The Two Leggins Ditch does have a moss collector about half a mile downstream from the diversion point.

Two Leggins Canal Headgate

5.14.2 Secondary Control Structure

A secondary control structure is located about ½ mile downstream from the initial diversion. This structure allows ditch operators to waste excess water into a side channel back to the Big Horn River during high flow periods or emergencies.

The secondary structure has a single large metal slide gate that is used to control the ditches overall water level. During a detailed evaluation of the system, it was noted that the metal slide gates pulley system does not work properly and causes a great deal of work for the ditch operators. Kevin is currently trying to fix the gate. Overall, the structural integrity of the system is sound and in fairly good working order.

About one hundred yards down ditch from the secondary control structure is a $350,000 moss catching machine that is used to keep the ditch flowing properly. It was reported that the unit is relatively maintenance free and is a crucial structure to keep the ditch in working order.

Moss Catcher Unit

5.14.3 Six Mile Spillway

This area is a typical distribution ditch located along the Two Leggins Ditch network. It is an area were ditch operators can divert flow to local farms for irrigation and cattle watering. Kevin said that most of the distribution ditches on the system are in good condition and little maintenance is required for upkeep on the systems. Pond weed and moss occasionally build up in this location and must be removed. There is a small siphon in this location which carries the ditch under a stream channel. The siphon itself is in very good condition but the concrete could use some repairs.

5.14.4 Drop Structure

The Two Leggins Ditch crosses the Interstate 90 and continues north to a drop structure. This drop structure lowers the ditch about 20 feet in elevation. Some major problems at this location cause the ditch operators more maintenance than necessary. This single-step drop is long and steep. The velocity of the water causes serious erosion issues and removes debris from the channel bottom. Large machinery is required to replace the washed out channel bottom and perform bank stabilization. In addition, the structure is in very poor condition. The concrete has deteriorated to the point where re-bar is exposed. A new drop structure that does a better job of dissipating flow energy would reduce maintenance and bring this component up to good operating standards.

Two Leggins Canal Drop Structure North of Interstate

5.14.5 Bank Erosion Issues

The ditch channel exhibits some erosion issues in a few locations. This leads to two maintenance issues. First, the eroding banks must be repaired and secondly, the increased sediment load in the ditch channel and distribution ditches must be removed.

5.15 Vigilante Canal Users Association, Sheridan, MT

This system was inspected on October 2, 2008. Evaluation was conducted by Lance Lehigh of PBS&J and Dell Beiroth, Ditch Superintendent.

5.15.1 Diversion and Control Structure

The Vigilante Canal Co. diverts water from the Ruby River, just below the Ruby Reservoir. The Vigilante Canal Users Association shares the diversion with the West Bench Canal Users Association. The diversion itself is made of concrete and spans the width of the river, which varies between fifty and 90 feet. The diversion dam runs perpendicular to the flow and channels water towards two large metal slide gates. The slide gates allow water to enter a canal which directs water to the West Bench Canal headgate. The diversion and control structure are in excellent condition and are well maintained. Although the Vigilante Canal users do not operate the initial diversion, they have a close relationship with the West Bench Canal operators.

The control structure is made of concrete and has two metal slide gates which are in good condition. A hand crank system is used to open and close the gates. The two associations that share this system rely heavily on water stored in the Ruby Reservoir. On dry years, the associations must work together to share the available water among their users.

5.15.2 Secondary Control Structure

A secondary control structure is used to divert water from the West Bench Canal into the Vigilante Canal. It consists of one large metal slide gate which allows water to flow into a 4- foot diameter siphon. The siphon channels the flow under the Ruby River. Once on the other side the canal heads northeast towards Sheridan. Along the way, there are a total of eleven siphons and several bridge crossings.

Vigilante Canal headgate

5.15.3 Vigilante Canal System Siphons

There are eleven siphons on the Vigilante Canal system. Most of the siphons have 4-foot wide entrances made of concrete. All the siphons are in good working order and provide excellent conveyance throughout the system. The two longest siphons on the system are the Alder Creek Siphon and the Elser Siphon. Each is approximately ¼ mile in length. Maintenance at these sites was reported to be fairly low, mainly consisting of debris removal and moss treatments.

Anderson Siphon Entrance

Anderson Siphon Exit

5.15.4 Concrete and Rip Rap Drop

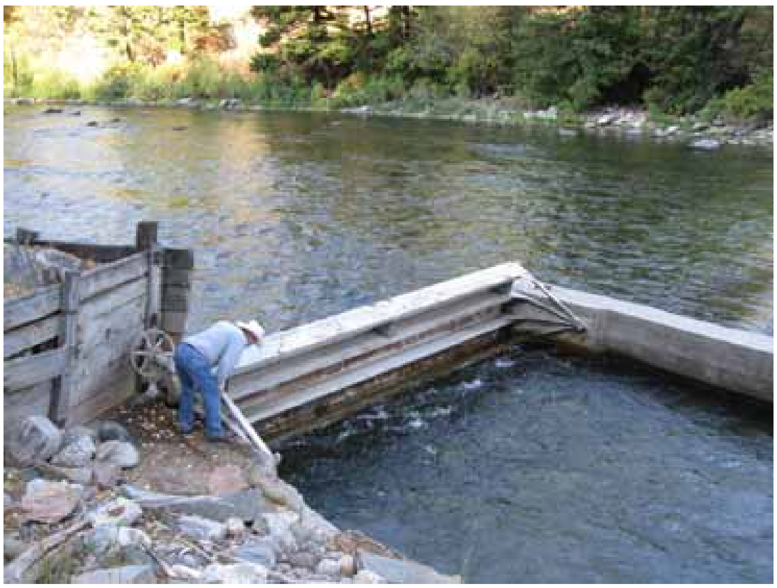
There are also multiple drop structures along the Vigilante Canal. Two of these were inspected. One was made from rip-rap and stone while the other consisted of concrete. The structures were in good condition and require little maintenance.

5.16 West Gallatin Canal Company,

This system was inspected on September 26, 2008. Evaluation was conducted by Lance Lehigh of PBS&J and Ray Vail, Ditch Superintendent.

5.16.1 Diversion and Control Structure

The West Gallatin Canal Company diverts water from the Gallatin River about six miles south-southwest of Gallatin Gateway. The initial diversion includes a concrete diversion dam that spans the width of the river and a large metal radial gate at the head of the canal channel. The radial gate is controlled by a cranking system which raises or closes the gate. Although the gate is in good condition, the diversion dam is inadequate. During low flows, it fails to create enough backwater effect to get water into the canal. The ditch company is exploring the idea of working with kayak enthusiasts to re-construct the diversion dam to serve as a water park and to improve flows into the canal.



West Gallatin Canal Radial Gate at Diversion

About 600 feet down the ditch from the initial diversion is a flow control structure made of concrete and wood. There are four wooden slide gates controlled by hand cranks and a wasteway to allow excess flows to return to the river. The structure is operating adequately though the wood is aging. Mr. Vail reported that during flood events, water overtops the wasteway. This could pose safety concerns.

Down-ditch from the four wooden slide gates is a large Parshall flume. The flume is in good condition and appears to measure water accurately.

5.16.2 Wilson Creek Crossing

There are several stream crossings along the West Gallatin Canal. In some locations, instead of attempting to carry the canal water over or under the streams as has been observed on other systems, West Gallatin employs the use of entry and exit points. At these crossings, the tributary stream is allowed to flow into the canal. There is a turnout on the opposite canal bank that controls the amount of water flowing out of the canal. The Wilson Creek crossing is one example. The structures associated with the crossing are in good condition and provide adequate flow back into Wilson Creek and on down to the main stem of the Gallatin River.

5.16.3 Big Bear Creek Crossing

Big Bear Creek is another example of the entry point-exit point type stream crossing. The structures in this area were poorly designed to begin with and are now old and deteriorating. The operator must place boards in the check structure from the bottom up. This causes gravel, sediment and debris to build up. When it comes time to remove the boards, they must be dug out. Additionally, the ditch channel must be excavated regularly to maintain conveyance in the ditch.

Bear Creek Entry Point (creek enters from right, in foreground)

Bear Creek Exit Point Structure

5.16.4 Cottonwood Creek Crossing

Cottonwood Creek is a third example of an entry point-exit point type stream crossing. This is the largest such crossing on the West Gallatin Canal. There are two major points that control the amount of flow through the ditch and back into Cottonwood Creek. Two metal slide gates control flow into the canal at this point. The exit point consists of one metal slide gate and a board-check system. There has been some deterioration of the concrete on this structure. If necessary, all the flow in the canal can be diverted down the Cottonwood Creek channel. The structure is in good condition and requires little annual maintenance.

5.16.5 Dry Creek Wooden Flume

A large flume is used to convey the canal over Dry Creek. The flume and support structures are made of wood. There is a leak at the entrance of the flume which is slated for repair. The flume is about 150-200 ft long and is lined at the entrance and exit with rubber matting. The rubber matting looked to be in good condition. In the center of the flume, a small head gate allows ditch operators to release water into Dry Creek to regulate flow in the ditch or in the event of an emergency. Although the structure is old, it still operates adequately.

Wooden Flume – Spillway Visible in Center

Ditch Operator Walking Across Structure

5.16.6 Middle Creek Metal Culvert Crossing

A large metal culvert carries water over Middle Creek. Although it is old, this culvert generally functions adequately. There is need of some repair work on the concrete piers and metal framing. At the entrance of the culvert, there is a small check on the left hand side that allows excess water to flow into Middle creek. The hand crank on the check structure does not function and needs repair.

5.16.7 Trash and Weed Issues

There are areas on the West Gallatin Canal where excessive amounts of debris collect and must be removed regularly. Other sections of the canal have an overgrowth of moss and algae which impedes water flow.

5.17 On-site Evaluation Discussion and Conclusions

The ten systems that were physically inspected provided a wide range of geographic diversity and a variety of different systems scales. Eight out of the ten systems had one or more significant structural problems that need to be addressed in the near future in order to maintain operations. However, most of the systems are currently operating fairly well in spite of the issues.

The Big Ditch Company had a few major concerns. During low flows, company personnel must do work in the channel in order to get enough flow directed toward the headgate. Though the diversion dam is in good condition structurally, it does not do an adequate job during low flows. Another concern is the make-shift trashrack that prevents debris from enter the headgate. This structure is in poor condition. Other concerns for the Big Ditch are issues related to urban/suburban encroachment, including overgrown vegetation along the ditch banks and the dumping of trash and grass clippings into the ditch. A culvert that was placed under Shiloh Road was apparently not sized properly and it now causes problems for the ditch company.

The Billings Bench Water Association Ditch diversion structure is in good condition. One exception to its generally good condition is the crank for moving the slidegates up and down which has become difficult to operate. This is probably more of a safety issue than a functional problem. This ditch system has several components that are operating adequately right now but are certainly at-risk structures that would be very expensive to repair and/or replace. The Association has a flume over Canyon Creek, a tunnel that goes through the Rims and several siphons that cross other small drainages. Bids the company received to replace just one of these siphons ranged from $225,000 to $300,000 depending upon the size and type of material chosen. Our inspector also noted safety issues with the siphons. There are no trashracks or any other structures to prevent people or animals from entering the siphon.

The Hellgate Valley Ditch Company system is in good condition. The Company recently re-built the rock diversion dam it has in the river and it is functioning very well. The diversion for this ditch is right in a developed area, just west of downtown Missoula. As the city has grown and roadways have expanded, etc. large sections of this ditch have been put into long culverts under the road and sidewalks. The ditch company secretary reported that this work has been paid for by the State and local governments in exchange for the ditch company agreeing to re-locate the ditch. If there are problems with any of the structures, the State and local governments are responsible for repairs. This is critical for a company with a small number of users where costs associated with replacement of major infrastructure could bankrupt the company.

The Kendall Ditch Company has some major issues with their diversion dam and their intake. The rock diversion dam needs to be repaired and the intake has no control gate on it so the flow cannot be regulated. Additionally, they have a problem with beavers clogging the channel and the intake culverts. The ditch is constricted at multiple points where culverts have been installed to allow people access to their property. The structures are in poor condition. Replacing the culvert crossings with bridges would greatly improve system function. Algae and pond weed are also problems all along this ditch.

The Lewistown Ditch Company diversion structure is on good condition. One problem on this ditch is a culvert under Highway 191. Apparently, the culvert was not installed properly and it is bent in the middle. This prevents water from flowing freely through the culvert. Some major erosion issues along the ditch require the operator to bring in fill material to prevent blow-outs.

The North Chinook Irrigation Association diversion structure is in poor condition. The concrete is deteriorating and the board check structure that helps get water into the diversion channel during low flows is not functional. The system really only operates well during high water. The ditch channel is overgrown with willows and weeds. The dikes and other structures associated with the storage facility are in good condition but the reservoir is shallow and covers a large surface area. A great deal of water is lost to evaporation, especially on hot windy days which are all too common in this part of the state.

The majority of the Two Leggins Canal Company system is in good condition. The diversion dam and flow control structures appear sound with only some minor cracking of the concrete around the headgate. The system employs a large moss-catching machine to remove pond weed and moss from the canal. Without this piece of equipment, the vegetation issues would be severe. The machine is currently operating normally but it will eventually need to be replaced. There is a drop structure on this ditch that is in very poor condition. The concrete has deteriorated to the point that the rebar is exposed. The large, single-step drop causes erosion problems in the channel at the bottom. There are a few other sections of the ditch that also have erosion problems.

The Vigilante Canal Company system is in good condition. They share the diversion with the East Bench Canal Company. There are eleven siphons along this system and several bridges crossing the ditch. All of the siphons are currently in good working order. Such structures will eventually need to be repaired or replaced which is very expensive.

The West Gallatin Canal Company's diversion dam is structurally sound but does not perform adequately during low flows. The headgate is in good condition. This system has several creek "crossings" where water from tributary streams flows into the ditch then openings on the other side allow the same amount of water to flow back out of the ditch. This configuration is much more low-tech than siphons or flumes and generally works well. One such crossing in particular though, the Bear Creek crossing, is poorly designed and in poor condition. The Dry Creek flume leaks and needs to be fixed.

Some of the issues identified during the evaluations are structural problems that could be addressed with the implementation of a discrete project, e.g. replacing a culvert or a siphon. Other items that were reported as problematic were not directly related to the age or condition of the system structures. The evaluations revealed issues with overgrown vegetation including woody vegetation on the ditch banks and near structures as well as algae, pond weed and moss growing in the water in the canals. This type of problem requires a high level of effort from ditch operators and water users on a continuous basis. Beavers and other rodents also cause maintenance problems that require regular attention. There is no one "fix" for these types of issues that will last for many years.

The Big Ditch and the West Gallatin Canal both experience difficulty with their initial diversions during low flow periods. The problems are not deficiencies in the structures rather they are due to changes in the river channel and flow regimes. Another commonly mentioned problem was channel migration and degradation. On some types of streams, channel movement is common. High water flows can cut into stream banks where diversion structures are located and cause severe damage. High flows can also cause stream channels to move completely away from existing diversion structures.

Fixing such problems can be very difficult and costly. A diversion may need to be completely relocated and re-engineered which may require professional expertise and permitting from multiple agencies. Special restrictions may exist on streams where there are plant and animal species of special concern. In most cases, when the diversion structures were originally constructed, such restrictions did not exist. The difficulty of overcoming these challenges may cause system operators and users to use less costly and usually less effective methods to get water into their ditches. This may result in a decrease in the available water supply.

The on-site evaluations revealed a higher level of impairments than the mail survey. Approximately 2/3 of the mail survey respondents indicated that their systems were not impaired while only two out of ten systems that were physically inspected could be considered not impaired.

6.0 Infrastructure Condition and Restoration Needs

6.1 Existing Condition of Physically Inspected Systems

The condition of the systems that were physically inspected ranged from good to poor. Ed's Creek Water Company, the Kendall Ditch Company and the North Chinook Irrigation Association all have major problems with their initial diversion structures. Other components of their systems are operating adequately however, this is of little use if little or no water can enter the system. The Ed's Creek structure still diverts adequate flows but is in imminent danger of failure. The Big Ditch and the West Gallatin Canal diversion dams are in good condition structurally however, both fail to provide adequate water during low flows. Modifying or rehabilitating any of these systems will likely require construction within the stream channel. This often necessitates obtaining permits from multiple agencies and hiring a professional hydrologist and/or engineer

The Big Ditch, Billings Bench, Lewistown, Two Leggins and the West Gallatin Canal all have structural issues along their conveyance facilities. On the Big Ditch, there is a culvert under Shiloh Road that does not pass adequate flows. Billings Bench has multiple siphons and flumes that need to be repaired/replaced. Lewistown has a problem with a damaged culvert under the highway and some serious erosion issues along the ditch. There is one drop structure on the Two Leggins Canal that is in very poor condition and a few areas of eroding ditch banks. The West Gallatin Canal crosses several tributary streams along its route and at least three of these crossings need repair.

The Hellgate Valley and Vigilante Canal systems are both in good condition. While Hellgate has been impacted by urban/suburban encroachment, this impact has not all been negative. Road construction and development have required a significant portion of the ditch to be placed in buried underground culverts. This has been done at the expense of state and local government and these agencies have agreed to assume responsibility for the maintenance and repair of these structures. This greatly reduces the efforts required of the ditch company to maintain the ditch and reduces problems that other systems in developed areas experience such as trash being dumped into the ditch.

The Vigilante Canal system is quite extensive with several large siphons along its route. All of the siphons and other system components were found to be in good working order and no problems were reported.

6.1.1 Underlying Reasons for Conditions of Physically Inspected Systems

Ed's Creek, Kendall Ditch and North Chinook are all systems on smaller order streams as compared to systems on the Yellowstone or the Clark Fork. Even in the best of conditions, the water supply for these systems is limited. Because of the limited water supply, they have relatively few users. Therefore, they lack the finances and/or the man-power/expertise to perform needed repairs. The result is that when problems occur, there is little money available for repairs. Less than optimal methods have been used to keep these systems functioning.

Poorly designed structures are likely the cause of some problems that were observed in the site evaluations. Culverts under major roadways on the Big Ditch and the Lewistown Ditch were either improperly sized or improperly installed and have led to issues on these ditches. It is not clear whose responsibility it is to fix these structures. One of the problematic stream crossings on the West Gallatin Canal was described as poorly designed.

Age of some systems is certainly a factor. Any physical structure in a dynamic hydrologic system such as an irrigation ditch is going to wear out eventually. Maintenance, such as diligent repair of concrete, can prolong the life of a structure, but not indefinitely.

6.1.2 Estimated Repair Costs for Physically Inspected Systems

Estimated repair costs for the physically inspected systems are listed below. The total is about $2.9 million.

Big Ditch	$1,500,000
Billings Bench	$500,000
Ed's Creek	$25,000
Hellgate	$0
Kendall Ditch	$250,000
Lewistown Ditch	$150,000
North Chinook	$150,000
Two Leggins	$150,000
Vigilante Canal	$0
West Gallatin Canal	$200,000
Total	$2,925,000

These estimated costs include repair of noted problems. They do not include costs for regular maintenance. Some system operators reported that they make an effort to line portions of the ditch each year or as often as they can afford it. The above estimates do not include costs for efforts such as this unless the lining is needed to resolve issues such as erosion or excess seepage that is causing damage.

6.2 Existing Condition Described by Mail Survey Respondents

Approximately 1/3 or more components to operate at less than full capacity. The other 2/3 indicated that there no impairments in their systems. When compared to the results of the on-site evaluations, where eight out of ten systems had noted infrastructure issues, it seems possible that respondents to the mail survey have understated the existence of system impairments. Perhaps, they considered that if the system is operating there are no impairments.

Other survey respondents were very explicit about the extent of the problems with their systems. Bitter Root Irrigation District, for example, provided a detailed response indicating the need for replacement of their first siphon, which was estimated to cost $6 million. Others provided similar detail and noted that costly repairs were needed.

Several survey respondents expressed concern about ability to pay for needed repairs. Some of these responses indicated that the operators did not think that there were any funds available for assistance. If the survey responses are taken at face value, the conclusion is that approximately 1/3 of the irrigation water supply organizations have some impairment and the other 2/3 are in good working order.

6.2.1 Underlying Reasons for Conditions of Mail Survey Respondents

It is difficult to judge the reason for the infrastructure condition from the responses to the mail survey. There is a perception by some that poor infrastructure condition is often due to "deferred maintenance" or that system operators do not invest in repairs until problems become severe. The responses to the mail survey do not provide evidence to support or contradict this notion.

Wide varieties of systems were included in the responses. Some systems are quite extensive and complex involving structures for conveying ditches across or under major rivers and roads. Even crossing small tributary streams can necessitate structures that increase maintenance requirements. When large complex systems are also very old, the likelihood increases that expensive repairs will be needed.

One problem reported by some respondents were issues with channel migration or degradation. In some parts of the state, stream channel changes commonly occur especially after high run-off events. Often little can be done in the way of preventative maintenance to control channel migration issues. Depending upon the severity of the problem, these issues can be quite expensive to resolve.

Many smaller systems were included among the survey respondents. In contrast to the situations observed on systems like the Kendall Ditch, many of these system operators indicated that they had no problems. Comments on some of the surveys returned by some smaller operators indicated maintenance and repair work was donated or conducted by the water users themselves, which controls costs.

6.2.2 Estimated Repair Costs for Mail Survey Respondents

According to the mail survey responses, costs for future projects to be conducted within the next five years were estimated to be between $5.7 and $56 million. The middle of this range, $25 million, is possibly a better representation of the projected costs.

7.0 Conclusions and Recommendations

Irrigation systems in Montana employ a wide variety of methods for diverting and conveying water from the source of supply to the locations where the water is put to use. This investigation has revealed that there is no "typical" irrigation system in Montana. If there is a common thread among the various systems across the State, it is that irrigation systems are subject to many natural and man-made forces. These forces result in the need for regular, sometimes nearly constant, maintenance and manipulation by system operators to sustain normal function. Changes in stream or river channel conditions are common natural occurrences with which operators must contend. Vegetation growth along ditch banks and near system structures also creates problems. The sheer force of water flowing through these systems causes soil to erode and all types of man-made materials to wear and degrade.

Faced with these issues and others including advanced age of many systems and system components, it is not surprising that there are reports of serious problems with the condition of Montana's irrigation infrastructure. This inventory of irrigation infrastructure was undertaken to provide the Montana Department of Natural Resources and Conservation (DNRC) and other decision makers with a better understanding of the condition of existing irrigation systems throughout Montana and an estimated cost of completing necessary improvements. The overall project included a summary of existing information about Montana's irrigation systems, a mail survey sent to irrigation water supply organizations and on-site evaluations of ten irrigation systems. A Geographic Information System (GIS) database was developed from the information that was gathered throughout this project.

The summary of existing information revealed that the majority of the US Bureau of Reclamation (USBR) and DNRC State Water Projects facilities are currently in fair to good condition. The USBR's Milk River Project is the major exception as there are several major infrastructure issues throughout this project. Other projects such as the Bitter Root project have one or two major issues but the remainder of the systems are in fair to good condition overall. However, the cost of resolving these major problems is large. The cost of repairs on the Milk River Project is estimated to exceed $150 million. The siphon that needs to be replaced on the Bitter Root Project will cost more than $6 million.

The DNRC has consistently conducted repairs and rehabilitation on the dams and canals that it owns and manages. Twelve of the twenty dams owned by DNRC have been rehabilitated in the recent past and are in good condition. Eight dams are in need of significant repairs or rehabilitation, some due to failure to meet current safety regulations and others because they are at or are nearing the end of the design life of the facilities. Over $90 million has been spent rehabilitating the DNRC dams and canals over the past twenty years and DNRC personnel estimate that more than $50 million needs to be spent over the next decade to bring all of the facilities into good working order.

These large government related systems account for a significant portion of the irrigated acreage in the state.

About 1/3 of the mail survey respondents described some type of irrigation infrastructure impairment. If this ratio, or even a similar one, is applicable statewide, then there are a significant number of systems that need repair. It is not known how critical these needs are. It would be misleading to derive an estimated cost for statewide repairs and indicate that this amount of money needs to be spent immediately to keep the state’s irrigation systems functioning.

Some of the infrastructure observed during the on-site evaluations confirm that at least some issues need to be addressed promptly. The North Chinook system, for example, is barely operable. In other cases, planning should begin immediately with the goal of completing the repairs within five to ten years. Some operators are making plans for future repairs and improvements. The Billings Bench Water Association has been working since 2000 to assess its structures and determine priorities for repairs. Other operators indicated that they have plans in place to install ditch lining or to replace open ditch laterals with pipelines to the extent possible each year.

More operators should be encouraged to assess their current situation and make realistic plans for future operations. Initial efforts would not necessarily require major financial investment. The USBR requires that the irrigation districts operating USBR facilities maintain reasonable financial reserves. Systems that currently operate with little or no cash reserves may want to consider following the USBR's approach and institute a program of depositing a reasonable amount into a reserve account each year.

One of the most commonly identified problems for irrigation system operators was dealing with vegetation issues. This included vegetation growing on ditch banks and adjacent to irrigation system structures as well as aquatic vegetation such as algae, moss and pond weed which clog canals and pipelines. Generally, this is not an infrastructure issue but a man-power issue. However, failure to address vegetation issues can lead to infrastructure damage. Successfully controlling vegetation along miles of open ditch can be nearly impossible given the limited number of man-hours that many of the water supply organizations can afford.

This study divided irrigation infrastructure components into three categories; diversion structures, conveyance facilities and storage facilities. Based on the estimation methods discussed in Section 5, there are approximately 194 diversion structures statewide that are in need of repair. More specifically, diversion dams and flow control structures were most likely to be the problem. The cost associated with repair or replacement of a diversion dam or a flow control structure depends mostly on the size of the stream or river from which the water is withdrawn. Structures located on large river systems require extensive engineering and permitting from multiple agencies in order to perform construction in the river channel.

Again, based on the estimation methods discussed in Section 5, there are approximately 152 impaired conveyance facilities across the state. Siphons and flumes were the infrastructure components most commonly identified as needing repair or replacement. These structures are often critical to system operation because they allow water to be conveyed across steep terrain and other obstacles where an open ditch would not function. The cost of repairing or replacing these components is closely related to the flow capacity of the structure. Siphons and flumes on large irrigation systems that have high flow capacities require extensive engineering and can cost millions of dollars to replace. Even on smaller systems, replacing a siphon or a flume can cost more than $150,000.

While not as common, dams associated with irrigation storage reservoirs are also problematic irrigation system components. Several water supply organizations involved in this investigation rely heavily or solely on the water stored in their reservoirs. Routine maintenance can help keep a storage facility in good condition however; any structure of this type has a design life and will require rehabilitation when that design life is at its end. The information from the DNRC State Water Projects Bureau indicates that dam rehabilitation is quite costly. Repairs for even a relatively small facility such as Fred Burr Reservoir are expected to cost approximately $2 million.

This investigation did not reveal any common theme among the systems that are in need of major repairs. While age of the systems can be a factor in infrastructure condition, there did not appear to be a direct correlation between advanced age and poor condition among the systems included in this study. Additionally, location within the state did not appear to be a factor as no geographic pattern in system condition was evident. Small systems and large systems each present challenges and advantages so size does not seem to play a particular role. Possibly further investigations would reveal some type of pattern that could be used to assist agency personnel and other decision makers.

One of the key goals of this project was to arrive at a general estimate of the investment needed to bring statewide irrigation infrastructure to full operating condition. The total costs estimated based on the mail survey data is one factor in the total state estimate. The costs estimated by the DNRC for SWP facilities and USBR facilities are other factors. The BIA has conducted studies on Indian Reservation irrigation projects but this information was not released for use in this current inventory. Table 21 lists the total statewide cost estimate based on the information currently available.

Source of Cost Estimate	Estimated Cost (in millions)
Mail Survey & Site Evaluation Derived	$131.7
State Water Projects	$51.5
US Bureau of Reclamation Projects	$160.0
Statewide Total	**$343.2**

Table 21. *General Statewide Estimate of Costs to Bring State Irrigation Infrastructure to Full Operating Condition.*

Since this is the first investigation of its kind undertaken by the DNRC, the information gathered here can serve as a baseline for future studies. In the absence of other statewide studies to use as a basis of comparison, it is difficult to judge if the current state of affairs represents a status quo condition related to the on-going need for maintenance and repair or if the current situation, if placed in an historical context, should be considered particularly good or bad. Further investigations would reveal if there is an upward or downward trend in the overall condition of Montana's irrigation infrastructure.

Prioritizing funding for irrigation projects is a daunting task. The costs associated with fixing the problems on some systems are much higher than what the water users can afford to pay. Based on discussions with operators such as John Crowley at the Bitter Root Irrigation District, the feasibility of paying for needed repairs through assessments on the water users in their district would make the cost of the water exorbitantly high. Other operators who responded to the survey or participated in the on-site evaluations expressed similar concerns about their ability to pay for repairs solely through water user fees. For example, the estimated cost for fixing the North Chinook system is $150,000. There are only nine users on this system for an average cost per users of over $16,500. It is clear that systems that require immediate costly repairs will require assistance from some outside funding sources.

Another item to consider is that the value of irrigation systems often goes beyond simply the value of the crops that are irrigated. Most of the irrigation systems around the state have been in existence for several decades and some have been around for a century or more. Ecosystems have developed in conjunction with the artificial presence of water. To use the Bitterroot as an example, a Montana Bureau of Mines and Geology groundwater characterization study found that in the area below the BRID irrigation canal, there is a strong correlation between static water levels and the time of year when there is water in the ditch. If the BRID system failed and no water was available in the canal, the east side of the valley would change drastically. Many people who rely on wells for their domestic water may find their wells going dry.

The Milk River system is an even larger example of this phenomenon. According to the USBR there are approximately 121,000 acres irrigated from the St. Mary's/Milk River Project. A price tag of over $150 million seems quite high for the potential value of the irrigated crops. However, the entire Milk River ecosystem is dependent upon water from the St. Mary's diversion. The diversion also supports municipal, industrial and recreational uses of water in the Milk River system.

The nature and possibly the location of a problem on a ditch system may determine how critical the need for assistance is. A problem at or near the beginning of a ditch system which would render most or all of the system inoperable would be considered a higher priority than a problem near the end of the ditch. The potential for irrigation infrastructure failure to cause damage to other structures or to the environment is another important factor to consider.

The results of this study are just a beginning. The contact list that was developed and revised for this project will allow the State to improve communication with irrigation system managers and operators. Some system managers and operators expressed the sentiment that believe they are out there all on their own and that there is no assistance available. Educational efforts may be beneficial in such cases. Some systems need financial assistance and some could benefit from technical assistance such as developing maintenance logs and schedules and preparing grant applications. Many system operators are "old-timers". There is a high potential for loss of institutional knowledge about the history and operation of these systems. If possible, efforts should be made to document important operational information.

Continued maintenance of the contact information database is recommended to facilitate communication. Publishing the ditch system GIS data on the web would also be helpful so that people can at least get the name of a ditch in their area when they need it. The City of Billings publishes a list of the names and contact information for the ditch companies in the area. A similar effort statewide could be very useful. Water supply organizations could be asked to be included on a voluntary basis. The DNRC should also consider doing a follow-up mail survey every few years. The questionnaire that was developed for this project could be modified and used for this purpose.

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9.0 End Notes

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Appendix A

Irrigation Infrastructure Survey Questionnaire

PBSJ

Company, District or Association

Ditch Name

Irrigation Infrastructure Survey Questionnaire

A. DIVERSION AND/OR FLOW CONTROL STRUCTURE ON THE MAIN SOURCE/NATURAL WATERWAY

1. Components of the initial diversion (check all that apply)

☐ Diversion dam – permanent ☐ Diversion dam – temporary ☐ Ditch
☐ Pipeline ☐ Culvert ☐ Pump or pumping plant
☐ Flow control structure (e.g., headgate) ☐ On-stream dam with impoundment
☐ Other (please describe) ______________________________

2. Do you share the initial diversion with any other water users? ☐ Yes ☐ No

If yes, are the other users: ☐ Multiple Individuals
☐ Ditch company or other organization Name ______________________________

3. When was the current diversion structure installed or last replaced/reconstructed?

☐ 0-10 years ago ☐ 10-50 years ago ☐ More than 50 years ago

4. Type(s) of material in diversion structure

☐ Metal ☐ Wood ☐ Concrete ☐ Earth
☐ Other (please describe) ______________________________

5. Is your initial diversion operating at less than 100% capacity due to impairment? ☐ Yes ☐ No

a. **If yes, how would you rate the operation of the structure?**

☐ 0 – 25% of capacity ☐ 25 – 50% of capacity ☐ 50 – 75% of capacity ☐ 75 – 99% of capacity

b. **What is the nature of the impairment?**

☐ Worn out or damaged component(s)? Check all that apply
☐ Diversion dam ☐ Ditch ☐ Pipeline ☐ Culvert
☐ Pump or pumping plant ☐ Flow control structure (e.g., headgate) ☐ On-stream dam
☐ Other (please describe) ______________________________
☐ Channel migration, degradation, sediment accumulation in the channel?
☐ Other (please describe) ______________________________

6. When do you estimate your initial diversion structure will need to be replaced?

☐ 0-5 years ☐ 5-10 years ☐ 10-20 years ☐ More than 20 years from now

7. What level of effort is required for <u>annual</u> maintenance at the main diversion(s)?

☐ Low – for example:
minor clearing of debris from diversion structure, ditch, adjacent streambanks
clean/inspect mechanical parts for proper operation

☐ Medium – for example:
placement of tarps or other temporary structures
work requiring mainly hand tools or small equipment
use of machinery to operate headgate

☐ High – for example:
work requiring heavy equipment and/or a 310 permit from the Conservation District
replacement of diversion component(s)

8. Does the initial diversion require a <u>high</u> level of maintenance but not on an annual basis? If yes, how frequently?

☐ Once every 2-3 years ☐ Once every 4-5 years ☐ Once every 6+ years

9. Could the level of annual maintenance be reduced if a particular reconstruction or rehabilitation project were completed? If so, please briefly describe the project.

☐ Yes ☐ No

Project description ______________________________

10. If your diversion has a headgate or other flow control structure, what type is it?

☐ Slide gate ☐ Wheel or screw valve ☐ Butterfly valve ☐ Ratchet gate ☐ Board control
☐ Other (please describe) ______________________________

11. When was the flow control structure installed or last replaced/reconstructed?

☐ 0-10 years ago ☐ 10-50 years ago ☐ More than 50 years ago

12. Type(s) of material in flow control structure (if present)

☐ Metal ☐ Wood ☐ Concrete ☐ Earth
☐ Other (please describe) ______________________________

13. Would you prefer a different type or design of flow control structure? ☐ Yes ☐ No

14. Do you have a measuring device on your initial diversion(s)? If so, what type of device is it?

☐ Parshall or other type of flume ☐ Weir ☐ Staff gauge
☐ Other (please describe) ______________________________

15. If you have a measuring device, when was it installed or last calibrated/checked for accuracy?

☐ Within the last 5 years ☐ Between 5 and 10 years ago ☐ More than 10 years ago

16. Are there any special features or conditions of your initial diversion you would like to comment on?

____
____
____
____
____
____

B. IS THERE A SECONDARY POINT WHERE YOU CONTROL YOUR WATER ALONG THE INITIAL DIVERSION DITCH OR CHANNEL? IF YES, PLEASE ANSWER THE QUESTIONS IN THIS SECTION. IF NO, PLEASE SKIP TO SECTION C.

1. Components of the secondary diversion (check all that apply)

☐ Diversion dam – permanent ☐ Diversion dam – temporary ☐ Ditch
☐ Pipeline ☐ Culvert ☐ Pump or pumping plant
☐ Flow control structure (e.g., headgate) ☐ On-stream dam with impoundment
☐ Other (please describe) ________________________________

____

2. When was the secondary diversion structure installed or last replaced/reconstructed?

☐ 0-10 years ago ☐ 10-50 years ago ☐ More than 50 years ago

3. Type(s) of material in diversion structure

☐ Metal ☐ Wood ☐ Concrete ☐ Earth
☐ Other (please describe) ________________________________

4. Is your secondary diversion operating at less than 100% capacity due to impairment?

☐ Yes ☐ No

a. **If yes, how would you rate the operation of the structure?**

☐ 0 – 25% of capacity ☐ 25 – 50% of capacity ☐ 50 – 75% of capacity ☐ 75 – 99% of capacity

b. **What is the nature of the impairment?**

☐ Worn out or damaged component(s)? Check all that apply
- ☐ Diversion dam ☐ Ditch ☐ Pipeline ☐ Culvert
- ☐ Pump or pumping plant ☐ Flow control structure (e.g., headgate) ☐ On-stream dam
- ☐ Other (please describe) ________________________________

☐ Channel migration, degradation, sediment accumulation in the channel?
☐ Other (please describe) ________________________________

____

5. When do you estimate your secondary diversion structure will need to be replaced?

☐ 0-5 years ☐ 5-10 years ☐ 10-20 years ☐ More than 20 years from now

6. What level of effort is required for <u>annual</u> maintenance at the secondary diversion(s)?

☐ Low – for example:
- minor clearing of debris from diversion structure, ditch, adjacent streambanks
- clean/inspect mechanical parts for proper operation

☐ Medium – for example:
- placement of tarps or other temporary structures
- work requiring mainly hand tools or small equipment
- use of machinery to operate headgate

☐ High – for example:
- work requiring heavy equipment and/or a 310 permit from the Conservation District
- replacement of diversion component(s)

7. Does the secondary diversion require a <u>high</u> level of maintenance but not on an annual basis? If yes, how frequently?

☐ Once every 2-3 years ☐ Once every 4-5 years ☐ Once every 6+ years

8. Could the level of annual maintenance be reduced if a particular reconstruction or rehabilitation project were completed? If so, please briefly describe the project.

☐ Yes ☐ No

Project description ____________________

9. If your diversion has a headgate or other flow control structure, what type of structure is it?

☐ Slide gate ☐ Wheel or screw valve ☐ Butterfly valve ☐ Ratchet gate ☐ Board control
☐ Other (please describe) ____________________

10. When was the flow control structure installed or last replaced/reconstructed?

☐ 0-10 years ago ☐ 10-50 years ago ☐ More than 50 years ago

11. Type(s) of material in flow control structure (if present)

☐ Metal ☐ Wood ☐ Concrete ☐ Earth
☐ Other (please describe) ____________________

12. Would you prefer a different type or design of flow control structure? ☐ Yes ☐ No

13. Do you have a measuring device on your initial diversion(s)? If so, what type of device is it?

☐ Parshall or other type of flume ☐ Weir ☐ Staff gauge
☐ Other (please describe) ____________________

14. If you have a measuring device, when was it installed or last calibrated/checked for accuracy?

☐ Within the last 5 years ☐ Between 5 and 10 years ago ☐ More than 10 years ago

15. Are there any special features or conditions of your secondary diversion you would like to comment on?

____

C. <u>CONVEYANCE FACILITIES</u> (CANALS, DITCHES, PIPELINES, FLUMES, SIPHONS, ETC.)

1. What types of materials make up the main part of your conveyance system (include the portions that serve multiple users not laterals that serve individual users) and what is the percentage of each?

2. Check all that apply and give percentage

Material		Percentage
☐ Gravel/cobble		________
☐ Sand/silt		________
☐ Concrete		________
☐ Metal		________
☐ Pipe (specify type)	________	________
☐ Other (please describe)	________	________

3. Can you estimate the amount of water lost through your conveyance system?

☐ 0 – 10% ☐ 10 – 20% ☐ 20 – 30% ☐ 30 – 40% ☐ 40 – 50% ☐ more than 50%

4. Are conveyance losses due to notable impairment(s) in the system?

☐ Yes ☐ No

5. If due to impairment(s), what is the nature of the impairment(s)?

☐ Worn out or damaged lining
☐ Leaks in above ground pipeline, siphon or flume
☐ Damaged concrete
☐ Poor ditch grading
☐ Overgrown vegetation
☐ Other (please describe) ____________________
☐ Leaks in buried pipelines
☐ Sloughing of upslope material in ditch
☐ Areas of porous substrate materials
☐ On-stream dam with impoundment

6. Are there other factors limiting the capacity or efficiency of your conveyance system?

☐ Yes ☐ No

7. Do any of the components of your conveyance system currently need to be replaced/reconstructed or will any need to be replaced/reconstructed in the next 5 years?

☐ Ditch ☐ Lining ☐ Pipeline ☐ Siphon
☐ Flume ☐ Drop box ☐ Turn-out ☐ Pump or pumping plant
☐ Other (please describe) ____________________

____

8. Are there any special features or conditions of your conveyance system that you would like to comment on?

____
____
____
____
____
____

D. STORAGE

1. Does your system involve one or more storage facilities?

☐ No ☐ Yes – One ☐ Yes – More than one Number of facilities: ________

a. **If not, is development of a storage facility physically possible for your location?**

☐ Yes ☐ No

b. **If development of a storage facility is possible, would you be interested in such a development?**

☐ Yes ☐ No

2. If your system does involve storage, is the impoundment located on-stream or off-stream?

☐ On-stream ☐ Off-stream

3. Approximately what percentage of your total water use is supplied by the storage facility?

☐ 0 – 25% ☐ 25 – 50% ☐ 50 – 75% ☐ 75 – 100%

4. Is your storage system operating at less than 100% capacity due to impairment?

a. **If yes, how would you rate the operation of the storage system?**

☐ 0 – 25% of capacity ☐ 25 – 50% of capacity ☐ 50 – 75% of capacity ☐ 75 – 99% capacity

b. **What component(s) is impaired or damaged?**

☐ Gate
☐ Intake structure
☐ Tower/Drop inlet
☐ Overflow channel
☐ Outlet pipe
☐ Dam Crest
☐ Downstream slope or toe
☐ Trashrack
☐ Drain
☐ Stilling basin
☐ Spillway
☐ Upstream slope
☐ Log Boom
☐ Outlet Works
☐ Other (please describe) ________

____

5. Are there any special features or conditions of your storage facility that you would like to comment on?

____
____
____
____
____
____

E. GENERAL SYSTEM QUESTIONS

1. Out of the irrigation system components listed below, identify 3 that are the primary factors limiting your system capacity and efficiency. Rate them according to the following:

1 – Most limiting 2 – Second most limiting 3 – Third most limiting

______ Diversion dam ______ Diversion structure ______ Flow control structure (e.g., headgate)
______ Ditch or canal ______ Flume ______ Drop box
______ Siphon ______ Pump or pumping plant ______ Pipeline
______ Storage Facility
______ Other (please describe) ____

____

2. Have you completed any reconstruction or rehabilitation projects in the past 10 years (beyond annual maintenance)? If so, what component(s) of the system was involved and approximately how much did it cost? Who provided funding? (check all that apply)

System Component	Approximate Cost Range				Funding Source			
	$500-$10K	$10K-$50K	$50-$500K	Over $500K	Federal	State	Local	Private
Diversion dam	☐	☐	☐	☐	☐	☐	☐	☐
Diversion structure	☐	☐	☐	☐	☐	☐	☐	☐
Flow control structure	☐	☐	☐	☐	☐	☐	☐	☐
Ditch or canal	☐	☐	☐	☐	☐	☐	☐	☐
Flume	☐	☐	☐	☐	☐	☐	☐	☐
Drop box	☐	☐	☐	☐	☐	☐	☐	☐
Siphon	☐	☐	☐	☐	☐	☐	☐	☐
Pump or pumping plant	☐	☐	☐	☐	☐	☐	☐	☐
Pipeline	☐	☐	☐	☐	☐	☐	☐	☐
Storage Facility	☐	☐	☐	☐	☐	☐	☐	☐
Other	☐	☐	☐	☐	☐	☐	☐	☐

3. Do you have plans for any reconstruction or rehabilitation projects that will be initiated in the next 5 years? If so, what component(s) of the system will be involved and approximately how much will it cost? Who will provide funding? (check all that apply)

System Component	Approximate Cost Range				Funding Source			
	$500-$10K	$10K-$50K	$50-$500K	Over $500K	Federal	State	Local	Private
Diversion dam	☐	☐	☐	☐	☐	☐	☐	☐
Diversion structure	☐	☐	☐	☐	☐	☐	☐	☐
Flow control structure	☐	☐	☐	☐	☐	☐	☐	☐
Ditch or canal	☐	☐	☐	☐	☐	☐	☐	☐
Flume	☐	☐	☐	☐	☐	☐	☐	☐
Drop box	☐	☐	☐	☐	☐	☐	☐	☐
Siphon	☐	☐	☐	☐	☐	☐	☐	☐
Pump or pumping plant	☐	☐	☐	☐	☐	☐	☐	☐
Pipeline	☐	☐	☐	☐	☐	☐	☐	☐
Storage Facility	☐	☐	☐	☐	☐	☐	☐	☐
Other	☐	☐	☐	☐	☐	☐	☐	☐

4. Are you aware of any reconstruction or rehabilitation projects that are needed but you do not have the means to accomplish? If so, please describe one such project and if possible, provide an estimated cost for completion of the project.

5. Have any assessments of your system been performed either by your own staff or by a third party? If so, are you willing to share a copy of the information that was gathered?

☐ Yes ☐ No

6. Do you have any GIS data on your system components and if so, would you be willing to share it?

☐ Yes ☐ No

7. If GIS data is maintained by a third party, would you be willing to request in writing that the third party share the GIS data with the State through PBS&J?

☐ Yes ☐ No

Appendix B

List of 229 Recipients of Irrigation Infrastructure Survey

PBSJ

Appendix B: List of 229 Recipients of Irrigation Infrastructure Survey

Irrigation Company Name	County	Manager Name
Antelope Basin Ditch Co	Carbon	Helen Mackay
Auwater Ditch Co	Sweet Grass	Stanley Stenberg
Bailey Ditch Co	Carbon	David Stark
Baker Ditch Co	Gallatin	
Bartlett Canal Co	Carbon	Marilyn Stephenson
Bass Lake Reservoir Co	Ravalli	Tom Ruffato
Beck & Border Ditch LLC	Gallatin	
Big Creek Lakes Reservoir Assoc	Ravalli	Kay Neal
Big Ditch Co Inc	Stillwater	Barb Walborn
Big Four Ditch Co	Yellowstone	Bill Mothershead
Big Hole Co-op	Madison	Dave Ashcraft
Big Horn Low Line Ditch Co	Big Horn	Greg Pattison
Big Horn Tullock Water Users Assoc	Treasure	Donlad G Bottrell
Big Timber Creek Canal Co	Sweet Grass	Laurie Cooney
Billings Bench Water Assoc	Yellowstone	
Bitter Root Irrigation District	Ravalli	John Crowley
Box Elder Ditch	Treasure	Dennis W. Kolb
Bozeman Creek & Reservoir Co	Gallatin	
Bozeman Trail Ditch Co	Big Horn	Roger Overturf
Brady Irrigation Co	Teton	Rollie Schlepp
Bridger Ditch Co	Carbon	Roxanne Tucker
Buffalo Land Co Water Users Assoc	Gallatin	Joe Walkusk I
Burrell Ditch Co	Gallatin	Richard E Gillespie
C & C Ditch Co	Ravalli	Ralph Maki
Cameron Ditch Co	Madison	Leanne Schroudner
Canyon Creek Ditch Co	Yellowstone	Jewel Baker
Canyon Creek Irrigation District	Ravalli	Brian Bachman
Canyon Irrigation Co	Beaverhead	
Carbon Canal Co	Carbon	Joe Yedlicka
Carlton Creek Irrigation Co	Missoula	Tom Macclay
Cartersville Irrigation District	Rosebud	
Charlos Irrigation District	Ravalli	Margaret Tavenner
Clark Canyon Water Supply Company	Beaverhead	William Hritsco
Clarks Fork & Silver Tip Ditch Co	Carbon	Randy Hergenrider
Clarks Fork Ditch Co	Yellowstone	Dodie Ziverfel
Clear Creek Ditch Co	Carbon	Darrell Stark
Clinton Irrigation District	Missoula	
Columbus Water Users Assoc/Merrill Ditch Co	Stillwater	Nadeen Kovanda
Consolidated Ditch Inc	Carbon	Loretta Sironen
Corvallis Canal & Water Co	Ravalli	Lee Erickson
Coulson Water Users Assn	Yellowstone	Barb Walborn
Cove Irrigation Co	Stillwater	Barb Walborn
Crowley Ditch Co	Fergus	Dick Tresch
D & D Irrigating Co	Madison	Tom Heintz
Daly Ditches Irrigation District	Ravalli	Nancy Schueler
Danford Irrigation District	Carbon	Jewel Baker
Davis Ditch Co	Yellowstone	John Berg
Dearborn Canal Co	Lewis and Clark	Joe Barrett
Delphia-Melstone Water Users Assn	Musselshell	
Dillon Canal Co	Beaverhead	
Dry Creek Canal & Irrigation Co	Carbon	Lanette Brown
Dry Creek Canal Co	Sweet Grass	Mike Clayton

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Irrigation Company Name	County	Manager Name
Dry Creek Irrigation Co	Gallatin	Jeannie Anderson
East Bench Irrigation District	Beaverhead	
Eds Creek Water Co	Missoula	Raymond Bennett
Elbow Creek Ditch Co	Park	Wanda M Melin
Elbow Ditch Co	Carbon	Terri Wetstein
Eldorado Co-Op Canal Co	Teton	Rodney Cole
Elk Hills Irrigation Co	Madison	
Etna Ditch Co Inc	Ravalli	Clark Mathison
Farmers Canal Co	Gallatin	Roxi Davis
Farmers Co-Op Canal Co	Teton	Shirley Hodgskiss
Farmers Ditch Co	Big Horn	Floyd Bastrom
Finn Ditch Co Inc	Carbon	
Fish Creek Ditch Co	Jefferson	Michael T Franich
Fort Peck Water Users Assn	Valley	
Fort Shaw Irrigation District	Lewis and Clark	Bill Bohmker
Fred Burr Creek WUA	Ravalli	
Free Silver Ditch Co	Carbon	Betty Grewell
Frenchman Irrigation Co	Phillips	Chet Barnard
Glen Lake Irrigation District	Lincoln	
Glenwood Ditch Co	Carbon	
Golden Ditch Co	Carbon	Lanette Brown
Grass Valley French Ditch Co	Missoula	Tim Fister
Green Meadow Seven Mile Water Users Association	Lewis and Clark	
Green Mtn Water Users Assn	Sanders	Bill Nolew
Greenfields Irrigation District	Teton	Bob Hardin
Grey Eagle Ditch Co	Yellowstone	Clark Schmidt
Grove Creek Canal Co Inc	Carbon	Clarence Jackson
Haara Ditch Co	Carbon	
Hammond Irrigation District	Rosebud	Marge Simenson
Hardesty Tract Irrigation Assoc	Custer	David Pratt
Hauf Lake Reservoir LLC	Ravalli	Ron Gearhart
Havre Irrigation Co	Hill	Jerry Bergren
Helena Valley Irrigation District	Lewis and Clark	
Hellgate Valley Irrigation Co	Missoula	Harvey Clouse
Henry Creek Irrigation Assoc	Lake	Cathy Saltz
High Line Canal Co	Gallatin	Eileen R Flikkema
Hogan Ditch Co	Sweet Grass	Betty Alexander
Holland Ditch Co	Carbon	Sonja Ogler
Holly Creek Water Users	Madison	Jeff Wingard
Hoy Ditch Co	Gallatin	Glen Kraft
Hunt Ditch Co	Carbon	
Hunter Hot Springs Canal Co	Park	Jan Engwis
Hunter-Russett Ditch	Carbon	Elta Ayre
Hysham Water Users Assoc	Treasure	
Indian Creek Ditch & Irrig Co	Madison	Ann Laszlo
Interstate Ditch Co	Big Horn	Charles Larsen
Italian Ditch Co Inc	Stillwater	Jewel Baker
Jefferson Canal Co	Jefferson	David Smith
Jette Meadows Water District	Lake	Donna Terry
Joliet Ditch Co	Carbon	
Kendall Ditch Co	Fergus	James E Phillips
Kent Ditch Co	Sweet Grass	Andy Butts

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Irrigation Company Name	County	Manager Name
Kinsey Irrigation Co	Custer	Bill Ziebarth
Kivikangas Ditch	Carbon	Curtis Schwend
Kohrs & Manning Ditch Co	Powell	
Kughen Ditch Co Inc	Gallatin	George Alberda
Last Chance Ditch Co	Carbon	
Lateral Water Users Assn	Big Horn	
Lewis Ditch Co	Gallatin	
Lewistown Ditch Co	Fergus	Joe Stilson
Livingston Ditch Water Users Assn	Park	Janet Lee
Lockwood Irrigation District	Yellowstone	Terry L Seiffert
Lolo Ditch Association	Missoula	
Low Line Canal Co	Gallatin	
Lower Jefferson Canal Co	Gallatin	
Lower Middle Creek Supply Ditch Co	Gallatin	Mike Ghffke
Lower Rock Creek Water Users Assoc	Park	Joe Magalsky
Lower Shields River Canal Co	Park	Robert F Eyman
Lower Swamp Creek Mutual Ditch Co	Sweet Grass	James Overstreet
Lower Willow Creek Irrigation District	Granite	
Maddison Irrigation Co	Madison	David Maddison
Mammoth Ditch Co	Gallatin	
Manternach Ditch	Daniels	Kenneth P Benson
Maryott Ditch Inc	Carbon	Manfred Maryott
Matheson Ditch Co	Blaine	David Warburton
Matson Ditch Co	Carbon	Arthur W. Ayers, Jr
Meagher County Newlan Creek Water District	Meagher	
Mendenhall Ditch Co	Stillwater	
Merrill Ditch Co	Stillwater	Dale Williams
Middle Creek Ditch Co	Gallatin	Kevin Haggerty
Middle Creek Meadows Water Users Assn Inc	Gallatin	
Mill Creek Irrigation Co	Deer Lodge	Darcy Delong
Mill Creek Irrigation District	Ravalli	Evon Stephani
Mill Creek Water Users Assn	Park	Jim Bechtel
Miller Mcgirl Ditch Co	Yellowstone	Ray Strecker
Missoula Irrigation District	Missoula	Ray Tipp
Montana Ditch Co	Broadwater	Marcia Bieber
Musselshell Ditch Co Inc	Musselshell	
Mutual Ditch Co	Carbon	Regina Aisenberey
New First Chance Ditch Co	Carbon	Malyn Oswald
New Granite Ditch Co	Carbon	Georgine Williams
New Prosperity Ditch Co	Carbon	
North Chinook Irrigation Assn	Blaine	
Norwegian Creek Reservoir Inc	Madison	
O'Dell Ditch Co	Madison	Jack R Reints
Old Hale Ditch Co	Gallatin	
Old Mill Ditch Co Inc	Yellowstone	Jewel Baker
Orchard Canal Co Inc	Carbon	Russ Cumin
Orchard Homes Ditch Co	Missoula	Marvin Ross
Pageville Canal Co	Madison	Gary Giem
Paradise Canal Users Assn	Park	Lou Ann Skattum
Paradise Trail Water Users Assoc	Ravalli	George S Masnick
Park Branch Water Users Assoc	Park	Lou Ann Skattum
Parrot Ditch Co	Madison	Joe Schlemmer

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Appendix B: List of 229 Recipients of Irrigation Infrastructure Survey

Irrigation Company Name	County	Manager Name
Perks Canal Corp	Gallatin	Evelyn Van Dyke
Petrolia Irrigation District	Petroleum	
Piegan Water Supply Co	Glacier	Selmar C Woldstad
Pioneer Ditch Co	Sweet Grass	Pat Dews
Pipestone Ditch Co	Jefferson	John Smith
Pleasant Valley Canal Co	Carbon	Tim Swansborough
Pleasant Valley Ditch Co	Jefferson	David Smith
Pondera County Canal & Reservoir Co	Pondera	Vern Stokes
Post-Kellogg Ditch	Sweet Grass	R Mark Josephson
Pryde Ditch Co	Carbon	Draper Ranch
Rancher Ditch Co	Treasure	Ruth Baue
River View Ditch Co	Carbon	Daniel Dutton
Rock Creek Canal Co	Valley	
Rock Creek Clear Creek Ditch Co	Carbon	Paulette Piccin
Rockvale Ditch Co Inc	Carbon	
Rocky Point Ditch Co	Carbon	Annette M Carlson
Rocky Reef Ditch Co	Cascade	Dan Sands
Ruby Water Co	Beaverhead	Carl Davis
Sand Creek Canal Co	Carbon	
Savage Irrigation District	Dawson	Jerry Nypen
Shane Ditch Co	Stillwater	Jenny Lorash
Shields Canal Co	Park	Alan Johnstone
Sidney Water Users Irrigation District	Richland	
South Side Canal Users Assn	Meagher	
Spain Ferris Ditch Co	Gallatin	
Suburban Ditch Co	Yellowstone	Norman Miller
Sullivan Ditch Users Assn	Ravalli	Bruce Nelson
Sun River Park Water Assoc	Cascade	
Sun River Valley Ditch Co	Cascade	
Sunnydale Water Assoc	Cascade	Raleigh Meade
Sunrise Reservoir Assn	Madison	Charles Wood
Sunset Irrigation District	Ravalli	Mark Mcfadgen
Supply Ditch Assn	Ravalli	Kari Trexler
Swan Water & Ditch Co LLC	Madison	
Sweeney Creek Water Users Assn	Ravalli	Beverly Ralls
Sweet Grass Canal & Reservoir Co	Sweet Grass	Cheryl Murray
Taylor Ranch Water Users Inc	Park	
Teton Co-Op Canal Co	Teton	Charles Crane
Teton Co-Op Reservoir Co	Teton	Vicki Baker
Three Creeks Water Co	Madison	
Tiffin Tracts Water Users Assn	Ravalli	
Tin Cup Water & Sewer District	Ravalli	Tex Marsolek
Tongue & Yellowstone River Irrigation District	Custer	Roger Muggli
Toston Irrigation District/Crow Creek Pump Unit	Broadwater	
Troutdale Assn	Madison	Bonnie Hernandez
Two Leggins Water Users Assn	Big Horn	
Union Ditch Co	Ravalli	Bill Strange
Upper Musselshell WUA	Meagher	
Valley Ditch Co	Gallatin	Carol Weidenaar
Victory Irrigation District	Big Horn	
Vigilante Canal Users Assoc	Madison	Neil Todd
Waco Custer Ditch Co	Yellowstone	

Appendix B: List of 229 Recipients of Irrigation Infrastructure Survey

Irrigation Company Name	County	Manager Name
Ward Irrigation District	Ravalli	Betty Frost
Warm Springs Canal Co	Gallatin	
Water Users Irrigation Co	Madison	Larry Link
Weast Ditch Co Inc	Carbon	Marilyn Weast
Webfoot Ditch Co	Ravalli	Clark Mathison
West Bench Canal Users Assoc	Madison	Neil Todd
West Fork Irrig Co Inc	Carbon	Harris Gabrian
West Gallatin Canal Co	Gallatin	Dick DeBernardis
West Madison Canal Co	Madison	Harry Combs
West Side Canal Co	Beaverhead	
West Side Ditch Co	Powell	Rick Cline
Whitehorse Canal Co	Carbon	Al Yager
Whitetail Water Users Assn	Jefferson	
Wills Canal Co	Carbon	
Winnett Irrigation Co	Petroleum	Ray Hale
Wiota Water Users Assoc	Valley	Duane Sibley
Woodside Ditch Co	Ravalli	Jr Iman
Woods-Parkhurst Ditch Co	Ravalli	Kari Trexler
Yellowstone Ditch Co	Stillwater	Peter Yegen Jr
Yellowstone Irrigation District	Treasure	Kathryn Smith
Youst Ditch Co	Carbon	Ken Tuss

Appendix C

All Survey Responses
(Separate Attachment)

Limited copies available.

Contact Alice Stanley, DNRC Conservation and Resource Development Division at 406-444-6687

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Appendix D

Contacts

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Contacts

First Name	Last Name	Title	Affiliation	Phone
Dave	Weaver	atty	AGAI	406-587-5511
Russ	Cumin	superintendent	Big Ditch	406-861-2659
John	Crowley	mgr	Bitter Root Irrigation District	
Larry	Draper	pres	Fred Burr Water Users Association	
Rich	Stucker	board	Blaine Conservation District - Chinook	406-357-3495
BJ	Schellin	board	Blaine Conservation District - Chinook	406-357-3803
Dwane	Skoyen	board	Blaine Conservation District - Chinook	406-357-3554
Jane	Alford	sec	Canyon Creek	
Steve	Selig	ditch rider	Cartersville Irrigation District	406-347-5249
Pam	Ash	sec	Cartersville Irrigation District	406-346-1600
Rob	Kingery		DNRC Water Projects Bureau	406-444-6790
Charlie	Atkins		DNRC Water Projects Bureau	406-444-6693
Dennis	Miotke	ditch rider	East Bench Irrigation District - Beaverhead, Westside Canal	406-683-2307
Roxie	Davis	sec/treas	Farmer's Canal	406-388-9803
Bill	Tatarka	pres	Farmer's Canal	406-587-2150
Ray	Tatarka	ditch rider	Farmer's Canal	406-586-6203
Harvey	Clouse	secretary	Hellgate	406-549-7389
Michael	Rich		Hydrometrics	
Virginia	Miller		Jefferson Canal Co	406-287-3865
Joe	Stilson		Lewistown Ditch Co	406-538-3588
Dan	Stilson		Lewistown Ditch Co	406-538-3567
Dan	Kimm		Lowline	406-539-2542
Marcia	Bieber		Montana Ditch Co	406-266-5627
Chuck	Hahn		Montana Ditch Co	406-266-5706
Mike	Inman	mgr	North Chinook	406-357-2227
Dave	Ashcraft		Pageville Canal Co	406-684-5762
Gary	Geim	sec	Pageville Canal Co	
Vern	Stokes	mgr	Pondera County Canal & Reservoir Company	406-279-3315
Andrea			Ruby Valley Conservation District	406-431-5535
Neil	Todd	ditch rider	West Bench Canal	406-842-5562
Ann	Schwend		Ruby Watershed Council	406-842-5741
Les	Gilman	chairman	Ruby Watershed Council	406-842-5010
Paul	A		St. Mary's	
Debbie	James Torske L	sec	Two Leggins Water Users Assoc.	406-665-1902
Kevin	Vandersloot	ditch rider	Two Leggins Water Users Assoc.	406-679-1611
John	Moody		US Bureau of Reclamation Ephrata Field Office	509-754-0243
Bill	Gray	mgr	US Bureau of Reclamation Ephrata Field Office	509-754-0214
Richard	Long		US Bureau of Reclamation Montana Area Office	406-247-7295
Joe	Metully		Vigilante Canal Users Association	406-684-5232
Steve	Burke	pres	West Bench	406-842-5152
Dick	DeBerardis		West Gallatin Canal Co	406-539-9400
Burt	Story		West Madison Canal Co	
Bob	Hardin	mgr	Greenfields Irrigation district	
Pat	Vaughn		Natural Resources Conservation Service	
Kevin	Elias	superintendent	North Chinook Irrigation Association	
Dell	Bieroth	superintendent	Vigilante Canal Users Association	406-596-0139
Jerry	Nypen	mgr	Lower Yellowstone Irrgiation District	

Appendix E

Geographic Information Systems Geodatabase Description and Metadata

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Appendix E
Geographic Information Systems Geodatabase
Description and Metadata

The Irrigation Infrastructure Inventory Geodatabase is included on the DVD submitted with this report. The filename is "Irr_Inv_PBSJ.mdb". The database was developed using ESRI ArcMap 9.2 and Microsoft Access. Three feature datasets are included:

- Ditches_canals – contains line features
    - The ditches and canals included in this layer are features for:
        - the systems that responded to the mail survey
        - the systems that were physically inspected
        - State projects
        - USBR irrigation project canals
        - Data on the Flathead Irrigation Project developed by HKM & provided to PBS&J by Bill Greiman of the Reserved Water Right Compact Commission
        - Data on the Pondera County Canal and Reservoir Company (PCCRC) developed by PBS&J
    - The majority line features were copied from:
        - The digital Water Resources Survey data where it was available
        - The National Hydrography Dataset (NHD) downloaded from the Natural Resources Information Systems website where no WRS information was available
    - In a very few cases, there were no line features on either the WRS or the NHD data. These few ditches were entered through heads-up digitizing based on the 1:24,000 topo maps, 2005 NAIP photography and information from the water rights database.
    - The WRS ditch data for some counties were attributed with ditch names but many were not. None of the NHD ditches were attributed with ditch names. PBS&J added the ditch names based either on the WRS publication maps or from the ditch names on the USGS 1:24,000 topo maps.
    - The attribute table contains 2 unique ID fields that allow relates to other table, the "Dtch_Id" field and the Dtch_Id_IDP field. The tables that can be employed in these relationships are described below.
- Initial_Diversion_points – contains point features
    - This layer was created with XTools Pro version 3.0.0. The Convert Features to Points function was used to create point features at the "from" end of each line. It contains the same basic attributes as the Ditch_canals layer.
- Reservoirs – contains point features
    - This points included in this layer are:
        - USBR irrigation project reservoirs
        - State projects
        - Flathead Irrigation Project reservoirs

- Many of these points were copied from the Montana Dams GIS data downloaded from NRIS. Other points were digitized based on the NHD data.

In addition to the three feature datasets, there are several data tables in the GDB that serve different purposes. These are:

- Data tables:
  - "Owners" table includes the irrigation water supply organization name and contact information. The unique identifier in this table is the Co_Nm_Id
  - "Projects" table contains the names of all USBR and State owned projects and agency contact information. The unique identifier in this table is Proj_Id.
  - "Convynce_Condition_Tbl" table contains information from the mail survey regarding the impaired/not impaired status with regards to the conveyance facilities
  - "Initial_Div_Condition_Tbl" table contains information from the mail survey regarding the impaired/not impaired status with regards to the initial diversion structure
  - "Initial_Div_Age_Tbl" table contains information from the mail survey regarding the age reported for the initial diversion
- Cross reference tables:
  - "DtchXref" table contains the following fields:
    - DtchX_Id – the unique identifier for this table
    - Dtch_Id – the unique identifier for relation to the Ditches_canals feature dataset
    - Co_Nm_Id - the unique identifier for relation to the the Owners data table
    - Proj_Id – the unique identifier for relation to the the Projects data table.
  - "ResXref" table contains the following fields:
    - ResX_Id – the unique identifier for this table
    - Res_Id – the unique identifier for relation to the reservoirs feature dataset
    - Co_Nm_Id - the unique identifier for relation to the the Owners data table
    - Proj_Id – the unique identifier for relation to the the Projects data table.
  - These cross reference tables are necessary because there are many to many relationships between the feature datasets and the data tables

Appendix F

Electronic Files Available from DNRC

*** Geodatabase**
*** Complete Site Inspection Photolog and**
*** Complete Survey Response Spreadsheet**
***All Survey Responses**

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