AN INFRASTRUCTURE MANAGEMENT SYSTEM FOR ENHANCED IRRIGATION DISTRICT PLANNING

Wally R. Chinn[1]
Lawrence Schinkel[2]
Paul Elser[3]
Dave McGee[4]

ABSTRACT

Traditionally, the metered monitoring and quantification of water use by individual irrigators in Alberta has been almost non-existent. As the increasing competition for a limited and finite resource has become much more of a reality in some major river basins, this water management tool is now receiving much more critical attention. In response to that emerging need and a very specific water-sharing issue, a pilot water use-measuring project was devised and implemented within the concentration of just over 6,500 acres of private irrigation along the Canadian reach of the Milk River. This river basin is a unique watershed, rising within the foothills of western Montana, flowing northeastward into and across the southern-most region of Alberta and then back southeastward into northeastern Montana. It is associated with international water management agreements that are a challenge to administer effectively. A rigorous monitoring of water diversions and river flows is critical for the effective administration of the international water-sharing agreement. Of particular concern, for example, is the need to accurately quantify Canadian withdrawals of water that may have originally been diverted up-stream as American allocations. As a result, the Alberta Department of Environment has initiated a project to track instantaneous irrigation water withdrawals along the Canadian reach of the Milk River and have that information reported on a near real-time basis through a designated website.

INTRODUCTION AND BACKGROUND

A History of Irrigation Water Development

Land settlement in the American northwest and Canada's southwest was occurring relatively simultaneously in the latter part of the 19th century. This was

---

1 Manager - Irrigation Development; Alberta Agriculture, Food and Rural Development (AAFRD); 100, 5401 – 1st Ave. S., Lethbridge, AB, Canada T1J 4V6; wally.chinn@gov.ab.ca
2 Senior Monitoring Technologist; AAFRD; 100, 5401 – 1st Avenue S., Lethbridge, AB, Canada T1J 4V6; Lawrence.Schinkel@gov.ab.ca
3 SCADA Systems Manager; Alberta Environment; Provincial Building, 200 – 5th Avenue S. Lethbridge, AB Canada T1J 4L1; Paul.Elser@gov.ab.ca
4 District Approvals Manager; Alberta Environment; Provincial Building, 200 – 5th Avenue S. Lethbridge, AB Canada T1J 4L1; Dave.McGee@gov.ab.ca

particularly true in the semi-arid regions of southern Alberta and northeastern Montana in the 1870s through 1890s. To encourage agricultural land settlement, both countries encouraged the development of various irrigation projects that would help sustain the new farming ventures.

The watersheds of the eastern slopes of the Rocky Mountains were envisioned as the sustaining sources of that critical water resource. However, the region's river watersheds have no particular interest in political boundaries so there was some risk that, with the development of some diversions, political issues and some animosities could arise when those diversions by one country were seen to be a potential impact by downstream users in the neighbouring country.

Such was the case with both the St. Mary and Milk Rivers, whose basins and water courses traverse both southern Alberta (in Canada) and northern Montana (in the United States). In fact, in the case of the Milk River, it crosses the international border twice on its meandering journey to enter the Missouri River. Figure 1 illustrates the courses of the St. Mary River (a tributary in the Oldman River Basin, draining to Hudson Bay) and the Milk River (a tributary in the Missouri River Basin, draining to the Gulf of Mexico). These watersheds originate in an area known as the "Crown of the Continent".

In order to establish and protect prior water appropriations, the Canadian Government, in 1898 authorized the development plan for 500,000 acres of irrigation in southwestern Alberta, with the St. Mary River as the source (Gilpin 2000). At the same time, the American Government had laid claim to the Milk River which was relied upon to support irrigation project developments that were in various states of operation along the eastern Milk River valley, dating back, in fact, to the early 1980s (Azevedo 2004). With the implementation of legislation provisions of the American Reclamation Act of 1902, the situation was changing dramatically as American interests also demonstrated specific interests in the waters of the St. Mary River system, laying claim thereto to bolster supplies for their Milk River irrigation project developments. In an analogous fashion, Canadian interests set about, in 1901, to develop plans to divert water from the Milk River to add stability to the water supplies of the Canadian St. Mary Project, supplies that were in jeopardy of being seriously curtailed if American plans were implemented (Gilpin 2000).

By 1902, it was clear that the potential for serious international conflict over these transboundary waters was becoming more and more a reality. At that time, William Pearce was one of the key visionaries and early developers of irrigation projects in southern Alberta. In communications with project financiers and Canadian Government representatives, Pearce speculated that, ". . . the whole question of utilization by another country of international waters is in a very unsatisfactory condition." (Gilpin 2000).

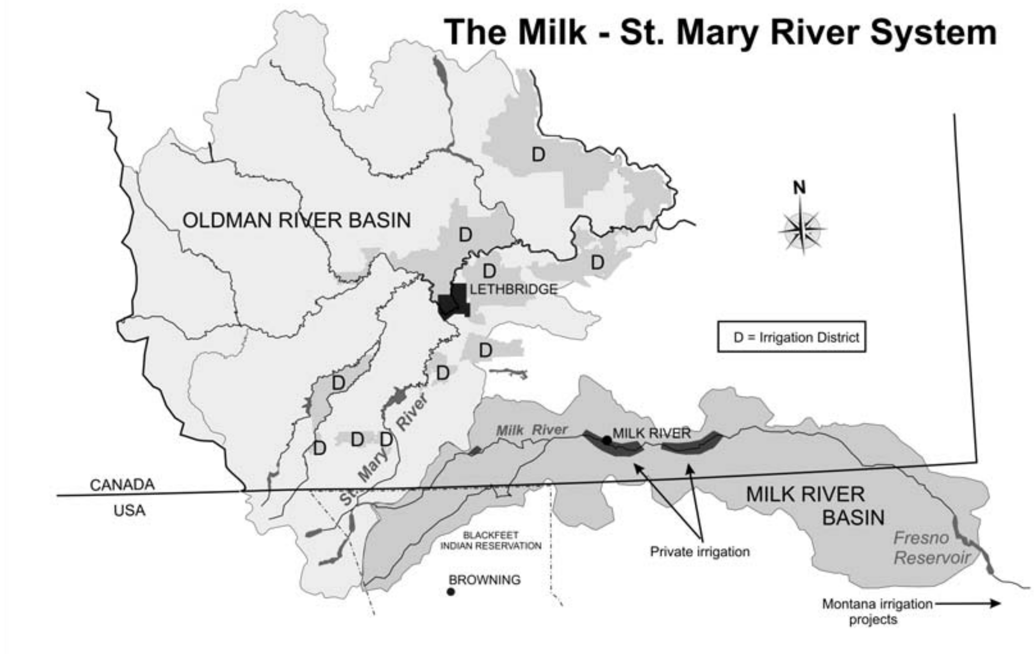

Figure 1. The Oldman and Milk River Basins which share water through international inter-basin transfer.

For example, the most contentious project, for Canadian interests, was the American concept to divert water from the St. Mary River into the Milk River to meet the needs in eastern Montana. In 1902, Canada requested that the U.S not proceed with this proposal as it could prove “injurious to Canadian interests” (Azevedo 2004). However, that request did not return a favourable response and because the Milk River, prior to reaching eastern Montana developments, runs into and through Canada, downstream of that inter-basin diversion, Canada proposed to build and implemented development of another weir. This structure was on the Milk River, just west of the current town of Milk River, and it would divert those waters again, into a newly constructed canal that would flow north and then west to reassure water supplies for the emerging Canadian St. Mary Project. Initial trial diversions took place by 1904. This Milk River diversion scheme was called the Canadian Milk River Canal, within Canada, but was more commonly referred to by the Americans as the Canadian “Spite” Canal (Gilpin 2000). Although this system never carried any water of significance and was never fully completed, for that matter, it had served notice as to its potential capabilities and impact.

INTERNATIONAL BOUNDARY WATERS TREATY

As these impacting issues were becoming quite contentious on both sides of the border, Canada and the USA had already initiated discussions on how best to divide these waters, holding various negotiation sessions late in1902 and again between October, 1903 and June, 1905 (Gilpin 2000). Subsequent to these and other follow-up discussions, a treaty concept concerning these international waters was proposed. As a result of discussions between both countries' federal governments, it was concluded that any such treaty should be able to deal with all internationally-shared waters between the two countries. The result was the signing, in 1909, of the Boundary Waters Treaty. This Treaty also created the International Joint Commission (IJC), which had and still has the responsibility to interpret the meaning, authority and application of various sections within the Treaty (Gilpin 2000).

Figure 2 illustrates the geographical location of the two principle river basins and the inter-basin transfer works developed more than 100 years ago. Today, the St. Mary – Milk River Diversion continues to operate to the primary benefit of American projects in the eastern Milk River Valley, while natural un-diverted flows of the St. Mary River continue to serve irrigation projects in southern Alberta.

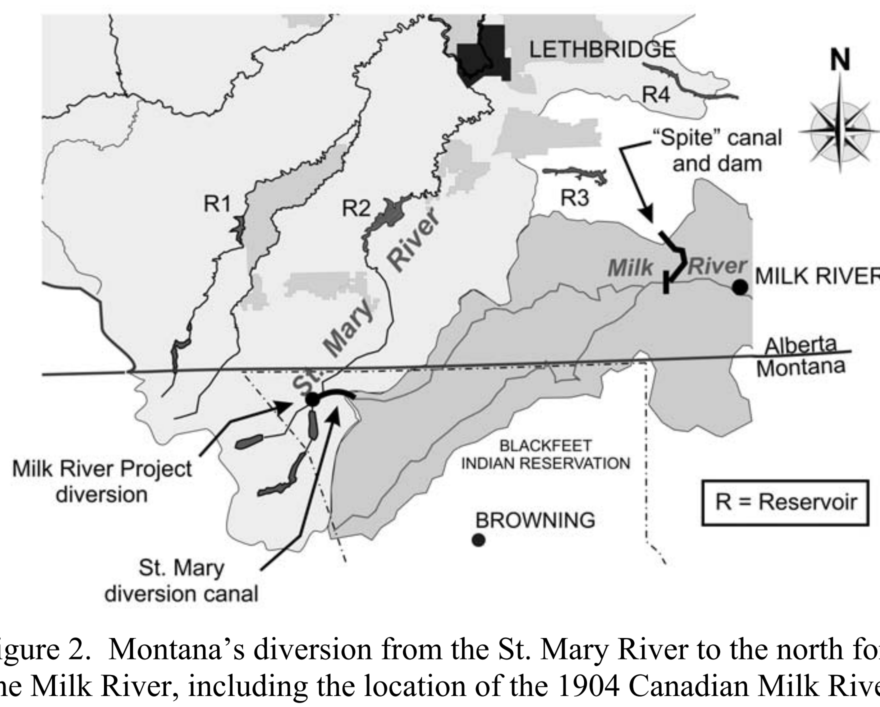

Figure 2. Montana's diversion from the St. Mary River to the north fork of the Milk River, including the location of the 1904 Canadian Milk River or "Spite" Canal.

The 1921 Order

Implementation of the Treaty proved difficult in the years after its signing, particularly as it applied to the situation with respect to the Milk and St. Mary Rivers (Article VI). Many more discussions and negotiations took place over several years, during which time both countries were also fully-engaged in developing their respective water diversion projects. Then, on October 4, 1921, the IJC issued an order respecting the measurement and apportionment of the water of the St. Mary and Milk Rivers.

The Order apportioned flows according to natural flows of the river during the "irrigation season"(April 1st through October 31st) and remaining non-irrigation season, as per the following summary.

a) During the irrigation season, when the natural flow of the St. Mary River at the point where it crosses the international boundary is 666 cfs or less, Canada shall be entitled to three-quarters and the United States to one-quarter of such flow.
b) During the irrigation season, when the natural flow of the St. Mary River at the point where it crosses the international boundary is more than 666 cfs, Canada shall be entitled to a prior appropriation of 500 cfs and the excess over 666 cfs shall be divided equally.
c) During the non-irrigation season, the natural flow of the St. Mary River at the point where it crosses the international boundary shall be divided equally between the two countries.

The Order continued to stipulate, in reciprocal fashion for the Milk River allocations, the same rate of flow criteria and apportioning, except that the proportion of allocations favoured the United States interests.

River Flows and Irrigation In Alberta

Of Alberta's 13 irrigation districts (1.34 million acres) and approximately 290,000 acres of private irrigation, eight of those districts (566,289 acres) and almost 42,000 acres of private irrigation depend on three small rivers (St. Mary, Belly and Waterton) in the most southwestern part of Alberta for their irrigation water supply (AAFRD 2005). These are often referred to as the "Southern Tributaries" of the Oldman River. The water supply to downstream users is reinforced through the inter-connection of these three rivers via a series of on and off-stream reservoirs, connected through large capacity diversion and conveyance canals (Figures 1 and 2). Some of these works are identified in Figure 2, where the labels R1 = Waterton Reservoir (on-stream), R2 = St. Mary Reservoir (on-stream) and R3 = Milk River Ridge Reservoir (off-stream). In addition, this system supplies water for 15 towns and villages, rural domestic supplies, several major agricultural processing and oil and gas industries. The municipal and domestic servicing provides water to support more than 30,000 persons, while several thousand head of livestock also depend on the assured water supplies that this system provides.

It is estimated that the St. Mary River and its on-stream reservoir supplies meet 50 to 60 percent of the annual water demand by all users in the system. As its headwaters are high in the eastern slope mountain watershed of the Rocky Mountains in Montana, its normal hydrology sees a more continuous flow from April through September, peaking, on average, in late May and early June.

River Flows and Irrigation In Montana

Irrigation within the eastern Milk River valley projects of Montana occurs within seven irrigation districts and several Indian Tribe projects. All together, through approximately 660 farms, more than 110,000 acres are irrigated each year. In addition, the Milk River is the source of water for the approximately 14,000 people in the communities of Havre, Chinook and Harlem, Montana (Azevedo 2004). Supply to this eastern reach of the river is stabilized to some degree through the on-stream Fresno Reservoir. Nonetheless, it is the water diverted from the St. Mary River into the North Fork of the Milk River that is the lifeblood for more assured water supplies along the Milk River. However, the Milk River watershed does not originate in the mountains but rather in the foothills and plains east of the Rocky Mountains. Therefore, its primary volume of flow occurs early in the year and generally prior to the main irrigation season. In most years, 70 percent of the Milk River flow near Havre originates as diversions from the St. Mary River basin. In dry years, the St. Mary River diversions can contribute between 90 and 95 percent of the Milk River flows (Azevedo 2004).

Disputing the 1921 Order and Searching for a Resolution

Although both countries share a common history of irrigation water use along and between these two river systems, the extent of development and on-going rehabilitation during that period has been distinctly different. While Canada and Alberta have reinvested nearly one billion dollars in developing, expanding and rehabilitating the irrigation water management infrastructure for the St. Mary Project, the Montana works are still the same basic infrastructure built by the U.S. Reclamation Service in the early 1900s. During that time, diversion and conveyance capacity has decreased and the functional integrity of the whole system is tenuous at best (Azevedo 2004).

Partly as a result of the state of the infrastructure and due to the variable hydrologic nature of the St. Mary flow regimes, the Montana diversions from the St. Mary to the Milk River have seldom achieved the entitlement as defined within the 1921 Order. Figures 3 and 4 illustrate the recent history of those diversions. As can be determined from Figure 4, on average, through the past 33 years, the U.S. has been able to capture or divert only a little more than 65 percent of its entitlement.

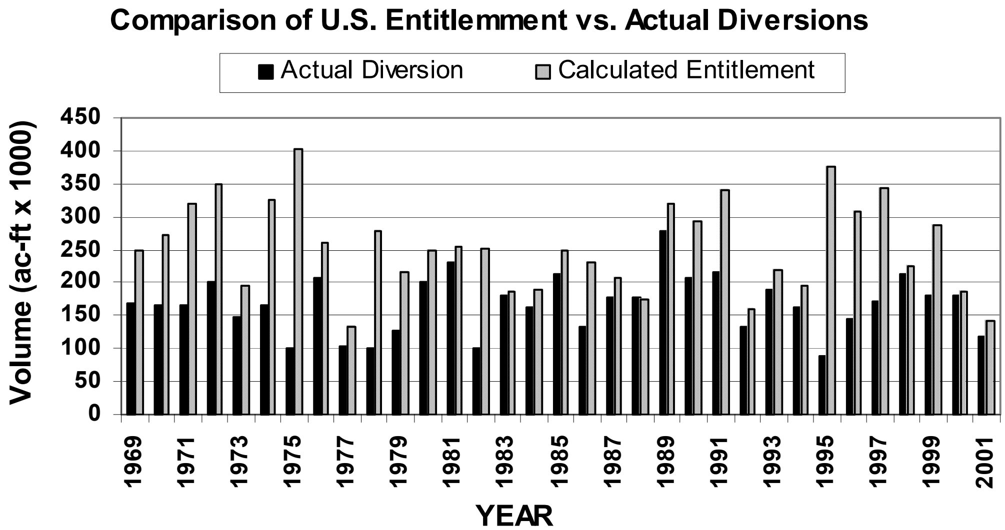

Figure 3. Historical U.S. diversions from the St. Mary River to the Milk River.

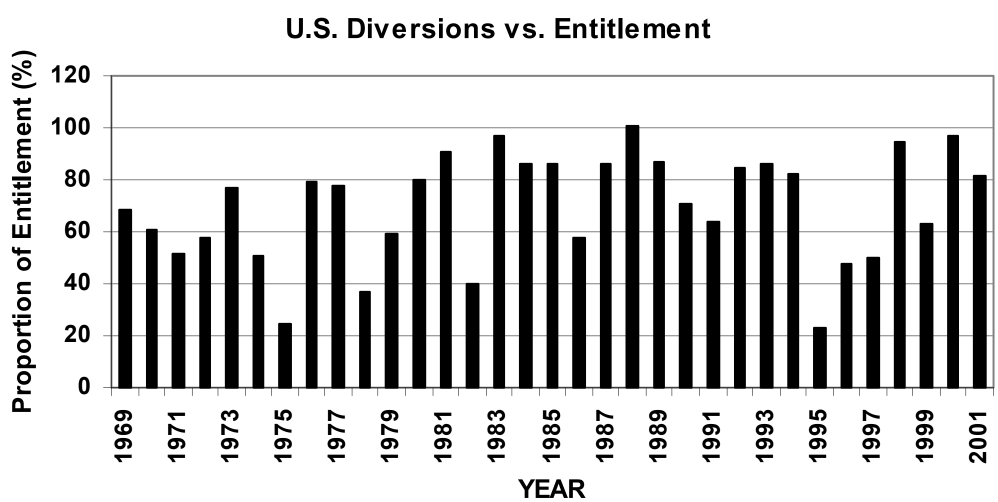

Figure 4. Proportion of actual U.S. diversions from the St. Mary River to the Milk River, relative to the Order entitlement (100%).

Montana has desperately needed to secure capital funding to restore system capacity and reliability. It has also been argued that if the water-sharing arrangement (1921 Order) were re-visited, with the end result providing adjusted mechanisms of apportioning flows that allow Montana to realize a greater portion of its entitlement, Montana could be in a better position to leverage more rehabilitation funding.

In a somewhat analogous fashion, water users along the Milk River in Canada have not been able to divert Alberta's appropriated share, as most of that natural flow occurs and passes on to Montana (Fresno Reservoir and beyond) in early spring, prior to the irrigation season. Therefore, when Alberta irrigators are withdrawing water during the June through August period, for example, it is disputed as to whether the water being diverted is actually Alberta's rightful natural flow entitlement or Montana's diverted St. Mary entitlement. Through all the discussions and renewed negotiations, there has been much conjecture about what Alberta irrigation water users have actually been diverting and whether those diversions are encroaching on Montana's St. Mary diversion entitlements, diversions that can often already be less than the Order allocates to Montana.

NEAR REAL-TIME FLOW MONITORING

Although gross diversions into major irrigation project or district blocks in Alberta are monitored and quantified on a comprehensive basis, measurement of water withdrawals through individual irrigator's works, particularly those outside the irrigation districts, has been quite limited or non-existent. This deficiency has existed despite the requirement for water use licensees to submit annual reports on their past year's consumption. Despite this requirement for annual water use reporting, the direct quantification of actual diversion amounts by individual irrigation water users, through metering, has not traditionally been a formal part of Alberta's water management policies and licensee operations. However, Alberta's recent *Water for Life* water management strategy for sustainability clearly defines an expectation that water use by all sectors will be more comprehensively monitored and reported in the immediate future.

Irrigation in the Milk River Basin – Canada's Portion

The individually licensed and operated irrigation projects, usually associated with single farming enterprises, with diversions from rivers, creeks, lakes, etc., are referred to, in Alberta, as "private irrigation projects". The irrigation diversions that are licensed for withdrawals directly off of the main stem of the Milk River that meanders its way through Canadian territory are typical of these private irrigation projects. There are approximately 50 projects that are authorized to divert water directly from the Milk River itself, for the irrigation of 8,200 acres of agricultural land. Most of these irrigation diversions are located in quite isolated areas which pose their own monitoring challenges.

Almost all of these projects now incorporate closed conduit pumping diversions to supply sprinkler irrigation systems that are primarily centre pivots but also include some wheel-move sprinklers as well. These projects are licensed to divert only that portion of the flow of the Milk River that is deemed to be the Canadian apportionment of the natural flow. However, the recent contentious nature of the water-sharing agreement between the two countries is suggesting that there needs to be a better and more accessible quantification of the actual Alberta irrigators' diversion volumes, for the information and benefit of the interests on both sides of the border.

Individual Pump Diversion Monitoring Systems

In early 2005, the Alberta Department of the Environment (AENV) initiated the development of a prototype water use monitoring and tracking project, specifically designed to encompass all irrigation diversions from the main stem of the Milk River in Alberta. It was intended that the new system would also test a leading-edge water use tracking system that would allow for the use of standard "off-the-shelf" metering systems and also incorporate such telemetry so as to provide near real-time data through a web-enabled configuration that would facilitate the monitoring by an array of interested water management agencies.

By October of 2005, 32 different diversion works (for 6,500 acres) had been outfitted with 40 flow metering devices. (Some sites had multiple diversions.) A mix of representative meter types were installed, including McCrometer in-line propeller meters, Seametrics insertion turbine meters, Seametrics insertion magnetic meters and a Grayline ultrasonic strap-on meter. To meet projected power requirements, all sites were commonly set-up with 50-watt solar panels and 100 amp-hour gel cell batteries. Figure 5 illustrates the conceptual near real-time data link from the meter, through telemetry components to the viewing system.

.

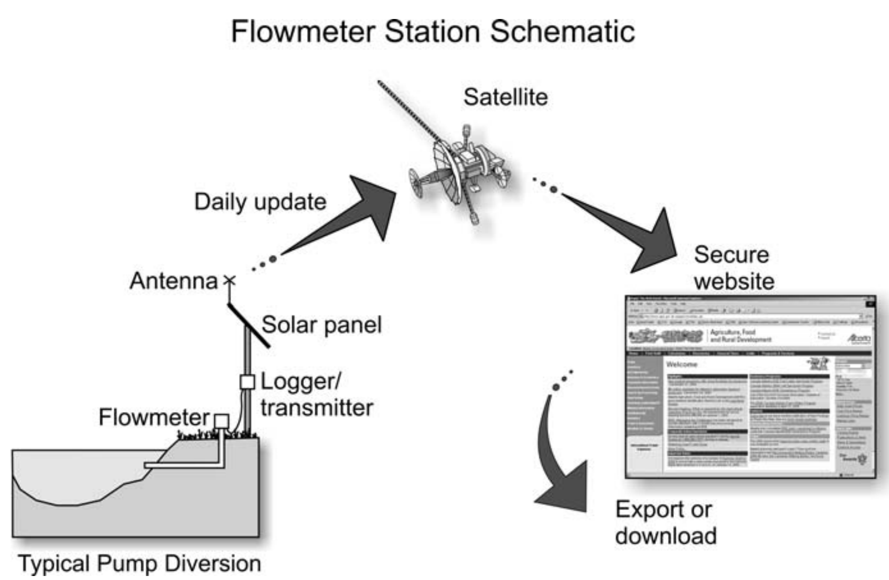

Figure 5. An illustration of the telemetry concept applied to the water use monitoring and tracking system.

Initially, various telemetry systems were installed at only ten of the sites in order that digital up-loads to a project website could be transmitted to develop and test the near-real-time aspect of the monitoring system. Again, the remote and isolated nature of most of these individual pump diversions tasked the enabling of the various telemetry assemblies.

As a result, several different types and configurations of data communication systems were installed for testing. These included:

- 4 ROM Communications systems (3 cellular and 1 satellite)
- 5 Optimum Instruments systems (5 cellular + 2 future satellite)
- 1 Bentek Systems Ltd. (AMCI) satellite-linked system

Both the ROM sites and the Optimum sites include dataloggers to ensure that data is not lost should there be a failure within the telemetry systems

CONCLUSION

The need for a solution to sharing the international waters of the Milk and St. Mary Rivers was the impetus that created the International Boundary Waters Treaty that references all water bodies shared between Canada and the United States. However, despite the solutions derived through recent and past history, it is clear that the escalating competition for water is going to require on-going enhancements of measurement and monitoring technologies in order to better document and quantify actual and finite water diversions and use.

As almost all the equipment and systems for the prototype development project were installed at or after the end of the 2005 irrigation season, there was very limited opportunity to test the installed systems. During the off-season, digital temperature gauges allowed, in a very basic fashion, operation verification of the telemetry components and development of the reporting website. With the start-up of the 2006 irrigation season, metering systems are in operation, equipment deficiencies or system anomalies are being detected and resolved and data is being acquired for further testing of all facets of the project concept.

REFERENCES

Alberta Agriculture, Food and Rural Development (AAFRD). 2005. Alberta Irrigation Information – 2004. Irrigation Branch. Lethbridge, Alberta Canada.

Azevedo, P. 2004. The Need to Rehabilitate the St. Mary Facilities. Department of Natural Resources and Conservation. Helena, Montana.

Gilpin, J.F. 2000. Quenching the Prairie Thirst – St. Mary River Irrigation District. Lethbridge, Alberta Canada