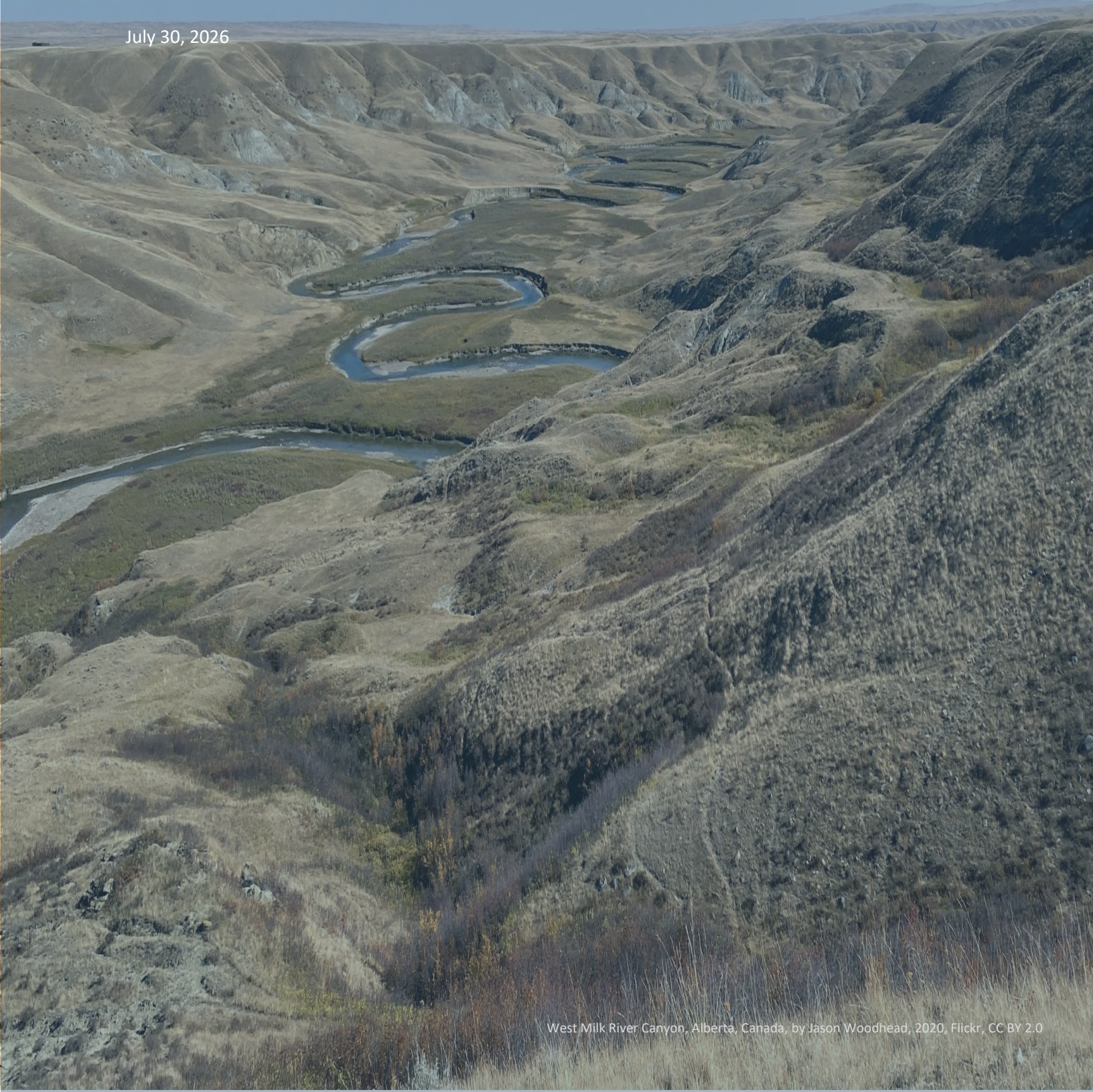


International St. Mary and Milk Rivers Study

International St. Mary and Milk Rivers Study Board

DRAFT

July 30, 2026



Letter of Transmittal

The International St. Mary and Milk Rivers Study Board is pleased to submit its final report to the International Joint Commission.

This Study addressed long-standing difficulties in how Canada and the United States share and use water under the 1909 Boundary Waters Treaty and the 1921 IJC Order. Over five years, the binational team—government agencies, technical specialists, Indigenous Nations, stakeholders, and community members—worked collaboratively to evaluate how procedural changes, infrastructure improvements, or both could enhance each country’s ability to reliably receive and use its full water entitlement. This collaborative structure was itself a major success, bringing together diverse perspectives and scientific expertise to examine future water management under changing climatic conditions.

The Study confirmed that while the apportionment framework has generally functioned as intended, neither country has consistently been able to receive its full entitlement due to infrastructure constraints, operational limits, and timing mismatches between water availability and demand. Climate and hydrologic modelling underscored the urgency of adaptation, showing trends toward warmer conditions, reduced snowpack, altered runoff timing, more evapotranspiration, and greater drought risk—especially in the Milk River basin. By integrating forward-looking climate analyses, the Study strengthened the basin’s preparedness and demonstrated the need for greater flexibility in water management.

A major achievement of the effort was its thorough evaluation of both structural and administrative solutions. The modelling showed that no single measure could resolve all apportionment challenges, but combinations of improved infrastructure and more flexible procedures produced significant gains. The Modified Annual Balancing approach emerged as the leading recommendation, offering substantial benefits while remaining simple and Treaty-consistent. Similarly, infrastructure improvements—such as rehabilitating the US St. Mary Canal to its original capacity and developing long-term storage on the Canadian Milk River—proved essential for enabling both countries to approach full receipt of their entitlements. Identifying these high-value, technically feasible options was a central success of the Study.

Finally, the Study succeeded by integrating environmental, social, Indigenous, and agricultural considerations into its recommendations. It emphasized the need for continued engagement and additional ecological studies, both of which support long-term watershed sustainability. By combining robust scientific modelling with broad stakeholder input, the Study produced practical, adaptive, and cooperative recommendations that represent a meaningful step forward in shared water management.

The Study Board expresses its sincere appreciation to all the individuals who contributed to the preparation of this report. From its beginning, the Study benefited from the engagement, ideas, and enthusiasm of the many interests in the St. Mary and Milk River basins.

We acknowledge and thank the members of the Study's Public Advisory Group, who helped prepare and carry out the Study's engagement and outreach activities so that the Study could better understand and respond to the concerns of the basin's residents and communities. The many members of the public who participated in public meetings, workshops, webinars, and other activities improved our understanding of the challenges in the basin and how governments could better address those challenges.

The Government Forum, made up of representatives of federal, state, provincial, and tribal water management and other agencies with responsibilities in the basin, worked to ensure that the Study's analysis and recommendations are realistic and compatible with their mandates and resources.

The Study Board is also grateful to members of many of the Tribes and First Nations in the basin, who through their participation in our Indigenous Advisory Group helped enrich our understanding of their connection to and interests in the basin's waters and their concerns about the future of those waters. We are united in our belief that the openness and communication that were nurtured during the Study must continue as governments consider new approaches to water apportionment in the basin.

The Independent Review Group established by the IJC helped ensure the scientific integrity of the Study's methodology and analysis through its peer review and comment. We sincerely appreciated their detailed comments on our work.

Finally, we want to thank the IJC for the opportunity to serve on the Study Board. Throughout the Study, we have listened to and learned from one another. We submit our report and its recommendations unanimously.

Signed – Co-Chairs and members of the International St. Mary – Milk Rivers Study Board

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Acknowledgments

The work of the International St. Mary and Milk Rivers Study Board represents a collaborative effort involving more than 100 individuals from Canada and the United States and is the culmination of five years of study. This final report has benefited greatly from the contributions of past and present Study Board members; technical leaders from the Options Formulation and Evaluation Group; members of the Technical Working Group; Study Managers; and the writing team. A comprehensive review of the report was also conducted by the Independent Review Group (IRG).

The Board extends its sincere thanks to all Study participants for their time, expertise, and dedication. We are also grateful to the many individuals and organizations that supported the Study's work and provided valuable input to strengthen the recommendations and improve communication of the results, including:

- Members of the Public Advisory Group, who advised Study members throughout the project and supported outreach efforts.
- Members of the public who attended meetings, workshops, and informational sessions, and who provided important feedback during the public comment period.
- Members from Indigenous Nations (First Nations, Tribes and Métis Nation) who participated in or observed the Indigenous Advisory Group. This includes members of the Kainai Nation (Blood Tribe), Cowessess First Nation, Métis Nation Alberta, Nekaneet Nation, Amskapi Piikani (Blackfoot Nation), Fort Belknap Indian Community, Fort Peck Tribes, Little Shell Tribe of Chippewa Indians of Montana, and the Blackfoot Confederacy Tribal Council.
- Environmental, economic development, and agricultural organizations, as well as watershed groups.
- State, provincial and Indigenous agencies that contributed staff expertise to support the technical work of the Study and participated in the Government Forum.
- Universities in Canada and the United States that supported Board members, Technical Working Group Co Chairs, and students involved in the Study.
- Federal government agencies in both countries that supported the Study's work, including Environment and Climate Change Canada and the US Geological Survey.
- The Commissioners, Liaisons, and support staff of the International Joint Commission, who provided guidance and support throughout the project.

A complete list of Study Participants can be found in the Supplementary Document: Study Participants.xlsx.

This final report was authored and submitted by LimnoTech.

Executive Summary

The International St. Mary and Milk Rivers Study was undertaken by the International Joint Commission (IJC) to address long-standing challenges in the apportionment and use of shared water resources between Canada and the United States. Despite the governing framework established under the 1909 Boundary Waters Treaty and the 1921 IJC Order, both countries have historically faced difficulties fully accessing their water entitlements due to hydrologic variability, infrastructure limitations, and rigid administrative procedures. The St. Mary River provides a relatively reliable, snowmelt-driven water supply, while the Milk River is highly variable and dependent on seasonal runoff and precipitation. This imbalance has resulted in differing levels of water security and irrigation development between the two basins, with the Milk River basin particularly vulnerable to shortages and drought. Climate change is expected to exacerbate these challenges by increasing temperatures, shifting runoff timing, and intensifying drought frequency and severity, especially in the Milk River basin.

The study evaluated a range of structural (infrastructure) and non-structural (administrative) options to improve each country's ability to utilize its entitled share of water. Using advanced hydrologic and water management models, the study assessed how combinations of infrastructure improvements and administrative changes could enhance water availability, irrigation reliability, and system flexibility under both current and future climate conditions. Results indicate that no single solution resolves all apportionment challenges. However, several options consistently improve outcomes. Administrative changes, particularly a modified annual balancing approach, provide increased flexibility in managing water across seasons and improve both countries' ability to access entitlements. Infrastructure improvements also play a critical role. Rehabilitation of the St. Mary Canal to its original capacity of 850 cubic feet per second (ft³/s) offers the largest benefit to the United States by significantly increasing water deliveries to the Milk River system. Additional storage in the St. Mary system enhances operational flexibility, particularly under higher canal capacity conditions.

For Canada, the study finds that increased storage on the Milk River is essential to fully utilize its entitlement. Without new storage, Canadian access remains constrained by limited ability to capture and retain flows during high-water periods. Larger storage options, such as the proposed Forks Reservoir, could substantially improve reliability and enable Canada to approach full use of its entitlement, while also increasing resilience to drought and interannual variability. The study also identifies important trade-offs. Improvements for one country may reduce flows available to the other, and economic impacts reflect differences in the value of water use across regions. Additionally, environmental considerations, including aquatic ecosystem health and flow needs for species such as bull trout, must be incorporated into future decision-making.

Overall, the study concludes that a combined approach is required. Implementing flexible administrative procedures, enhancing conveyance capacity, and developing additional storage—particularly in the Milk

130 River basin—would significantly improve the reliability and equity of water use between the two
131 countries. Continued collaboration, shared investment in infrastructure, and adaptive management will
132 be essential to address increasing variability and uncertainty under future climate conditions.

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List of Acronyms

AETWG	Aquatic Ecosystems Technical Working Group
AO	Accredited Officer
BWT	Boundary Waters Treaty of 1909
CDN	Canadian
CHTWG	Climate & Hydrology Technical Working Group
CMIP6	Coupled Model Intercomparison Project, Phase 6
DNRC	Montana Department of Natural Resources and Conservation
ECCC	Environment and Climate Change Canada
GCM	Global climate model
GF	Government Forum
HYPE	Hydrological Predictions for the Environment hydrological model
IAG	Indigenous Advisory Group
IDM-3	Irrigation demand model, version 3
IJC	International Joint Commission
IOTWG	Infrastructure Options Technical Working Group
IRG	Independent Review Group
JBOC	Milk River Joint Board of Control
LOI	Letter of Intent
MRP	US Bureau of Reclamation Milk River Project
MRWCC	Milk River Watershed Council Canada
OFEG	Operations Formulation and Evaluation Group
PAG	Public Advisory Group
PI	Performance indicator
PRMS	Precipitation-Runoff Modeling System
RBM	Results-Based Management
RID	Raymond Irrigation District
SEATWG	Socio-Economic Analysis Technical Working Group
SMRID	St. Mary River Irrigation District
STRIBS	Southern Tributaries
TWG	Technical Working Group
US	United States
USBR	United States Bureau of Reclamation
USGS	United States Geological Survey
WAAOTWG	Water Apportionment & Administrative Options Technical Working Group
WMMTWG	Water Management Modelling Technical Working Group
WRMM	Water Resources Management Model

Units of Measurement

Flow rate

1 cubic foot per second (ft^3/s) = 0.02832 cubic meter per second (m^3/s)

1 cubic meter per second (m^3/s) = 35.315 cubic feet per second (ft^3/s)

Area

1 square mile (mi^2) = 2.59 square kilometers (km^2)

1 square kilometer (km^2) = 0.386 square mile (mi^2)

1 acre (ac) = 0.405 hectare (ha)

1 hectare (ha) = 2.47 acres (ac)

Volume

1 acre-foot = 1.2335 dam^3 (decameter³)

1 dam^3 = 0.8107 acre-feet

1 dam^3 = 1,000 m^3 (meter³)

Distance

1 mile (mi) = 1.609 kilometers (km)

1 kilometer (km) = 0.621 mile (mi)

Temperature

1 degree Fahrenheit ($^{\circ}\text{F}$) = -17.222 degree Celsius ($^{\circ}\text{C}$)

1 degree Celsius ($^{\circ}\text{C}$) = 33.8 degree Fahrenheit ($^{\circ}\text{F}$)

Depth

1 inch (in) = 25.4 millimeters (mm) = 2.54 centimeters (cm)

1 millimeter (mm) = 0.1 centimeter (cm) = 0.0394 inches (in)

1 centimeter (cm) = 10 millimeters (mm) = 0.394 inches (in)

1 INTRODUCTION

The St. Mary and Milk Rivers and the lands they drain (Figure 1) have sustained people, animals, and the environment for millennia. In the late 1800s, as pressure increased from governments and settlers to develop farms and industry in the border region between Canada and the United States, disputes over the waters shared by the two nations became more frequent. The St. Mary and Milk River watersheds – two separate river basins that are treated as one for the purposes of the Boundary Waters Treaty¹ – straddle the border between the two countries. The desire by both countries to share a reliable supply of water for agricultural and ranch lands in southern Alberta and northern Montana led, in part, to the signing of the Boundary Waters Treaty (BWT) in 1909, and the creation of the International Joint Commission (IJC). The IJC prevents and resolves disputes over the use, obstruction, diversion, measurement, and apportionment of water that crosses the international boundary.

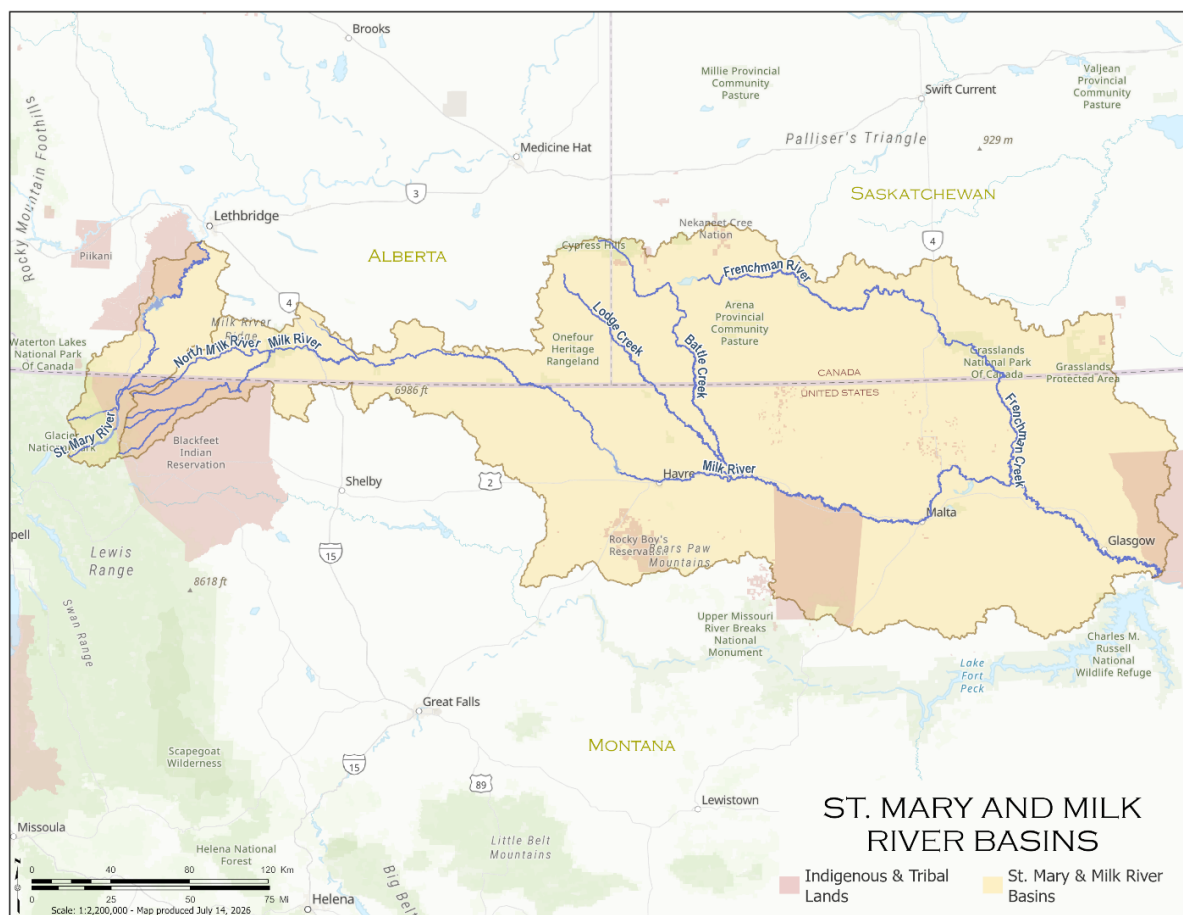


Figure 1. The St. Mary and Milk River Basin in Alberta, Saskatchewan, and Montana

¹ This report uses the term “Basin” to represent the overall St. Mary and Milk River Basin, the subject of this study, and “watershed” when referring to drainages of the individual rivers.

Article VI of the BWT specifically addressed the St. Mary and Milk Rivers, and an IJC Order was signed in 1921 with more detailed instructions on how the measurement and apportionment (sharing) of water from these two rivers is to be managed by the Reclamation and Irrigation Officers – now known as the ‘Accredited Officers’ (AOs) – appointed by the government of each country. Despite the Treaty and the Order, sharing of water in these watersheds remained a source of friction over the following decades, with each country finding it difficult to access or fully receive its entitlement of water at certain times. Periodic attempts to resolve the matter and resulting study efforts have allowed for some flexibility but have failed to solve the issue. Over the years, there have been many efforts to review how water is shared along the boundary, particularly in the face of present and expected future impacts from a changing climate and aging infrastructure used to store, regulate, and/or transport water.

Changing weather and runoff patterns are making water less available when users need it most. In 2019, the AOs proposed a study to identify potential changes in procedures and infrastructure that might improve each country’s ability to receive its entitlement of the water and add more flexibility in how water is managed in response to changing climate. To this end, the United States and Canada issued a letter on June 28, 2021, in support of the IJC’s plans to undertake a new study. Subsequently, the IJC issued a Directive on November 10, 2021, to create the International St. Mary and Milk Rivers Study Board (“Study Board”). The Study Board was formed to study and make recommendations to the IJC regarding structural (infrastructure) and non-structural (administrative) options and combinations thereof to improve each country’s receipt of their water entitlement.

1.1 Purpose of Report

The International St. Mary and Milk Rivers Study was launched in November 2021 to explore options to improve access to entitled waters by each country. Previous state and provincial efforts served as a starting point for the options considered. The effort reflects a desire to achieve long-term resilience in accessing the entitlement of the shared waters of the St. Mary and Milk Rivers. As the Study Board’s work was driven mainly by the directive to find ways for both countries to access their entitlements, much of the report examines the consumptive uses of water. The Study Board also examined the water necessary for aquatic health, but existing scientific evidence for the myriad of aquatic health components is limited.

In carrying out this study, the Study Board has integrated as many considerations and perspectives as possible as it explored options and combinations of options to improve access to entitled waters by each country, recognizing the challenges to apportionment and considering the risks posed by climate change. The Study structure and outcomes were designed to work towards mutually beneficial solutions for both countries. This report describes the study and presents the recommendations of the Study Board.

1.2 Study Setting

1.2.1 Physical Setting

The St. Mary River (Figure 2) begins in the high elevations of Glacier National Park, on the eastern slopes of the Rocky Mountains in the state of Montana. As the river descends to the plains below, it flows northeast through Amskapi Piikani (Blackfeet Nation) territory, crossing into the province of Alberta just east of the Piegan-Carway border station. It then flows northward, forming the eastern boundary of the Kainai Nation's (Blood Tribe) lands until it joins the Oldman River near Lethbridge, Alberta. Water in the St. Mary River continues north in the South Saskatchewan River and eventually discharges into Hudson Bay. The St. Mary River has a generally regular and dependable flow during the summer irrigation period because of its source in the high elevation snow fields and glaciers of Glacier National Park. Winter flows are sustained by groundwater.

The headwaters of the Milk River originate in the foothills of the Rocky Mountains in northwestern Montana (Figure 2). The waters of the North Fork of the Milk River are also fed by water from the St. Mary River, delivered through a 29-mi (47-km) canal system. Both the North Fork and the main stem of the Milk River then flow northeast across Amskapi Piikani territory before crossing into Canada, where they join west of the town of Milk River, Alberta. The Milk River then flows easterly through the province before crossing back into Montana about 25 mi (40 km) west of the Alberta-Saskatchewan provincial border. The river passes through the Fresno Reservoir near Havre, Montana and turns eastbound, forming the northern border of the Fort Belknap Indian Community lands, and eventually joining the Missouri River just downstream of Fort Peck Dam. The river flow is dependent on spring snowmelt and rainfall in the foothills and is thus less regular and dependable than the St. Mary River as a source of water.

Irrigation in both these watersheds began over 100 years ago. Early on, settlers in the United States realized the St. Mary River consistently provided a larger and more reliable water supply and they made plans to divert St. Mary River water into the North Fork of the Milk River for use on the Great Plains in eastern Montana to address irrigation needs. Canadian settlers also made plans to use the larger and more reliable St. Mary River water supply for large scale irrigation from the river's mainstem north of the border. In the early 1900s, each country made plans to construct a canal to divert water for irrigation. These competing interests in using the limited available water led to the inclusion of water apportionment in these watersheds under Article VI of the Boundary Waters Treaty.

The United States proceeded with its diversion plans, and the US St. Mary Canal, which diverts water from the St. Mary River to the North Fork of the Milk River, was completed in 1917. Figure 3 provides a schematic diagram showing the diversion and key locations in the basin for the St. Mary and Milk Basin. Key structures used to manage the diversion of water from the St. Mary to the Milk River include Lake Sherburne Dam, the diversion dam, siphons and five drop structures of the St. Mary Canal.

Lake Sherburne, which lies on Swift Current Creek, a tributary of the St. Mary River, stores water in the winter and during high spring flows. Lake Sherburne is the only major storage facility (storage capacity

- 1 approximately 67,850 ac-ft (83,692 dam³) in the United States headwaters of the St. Mary River. Water
- 2 stored in Lake Sherburne is released into the St. Mary Canal during irrigation season, depending on
- 3 weather and hydrologic conditions. The Sherburne Dam controls the outlet from Lake Sherburne.

4

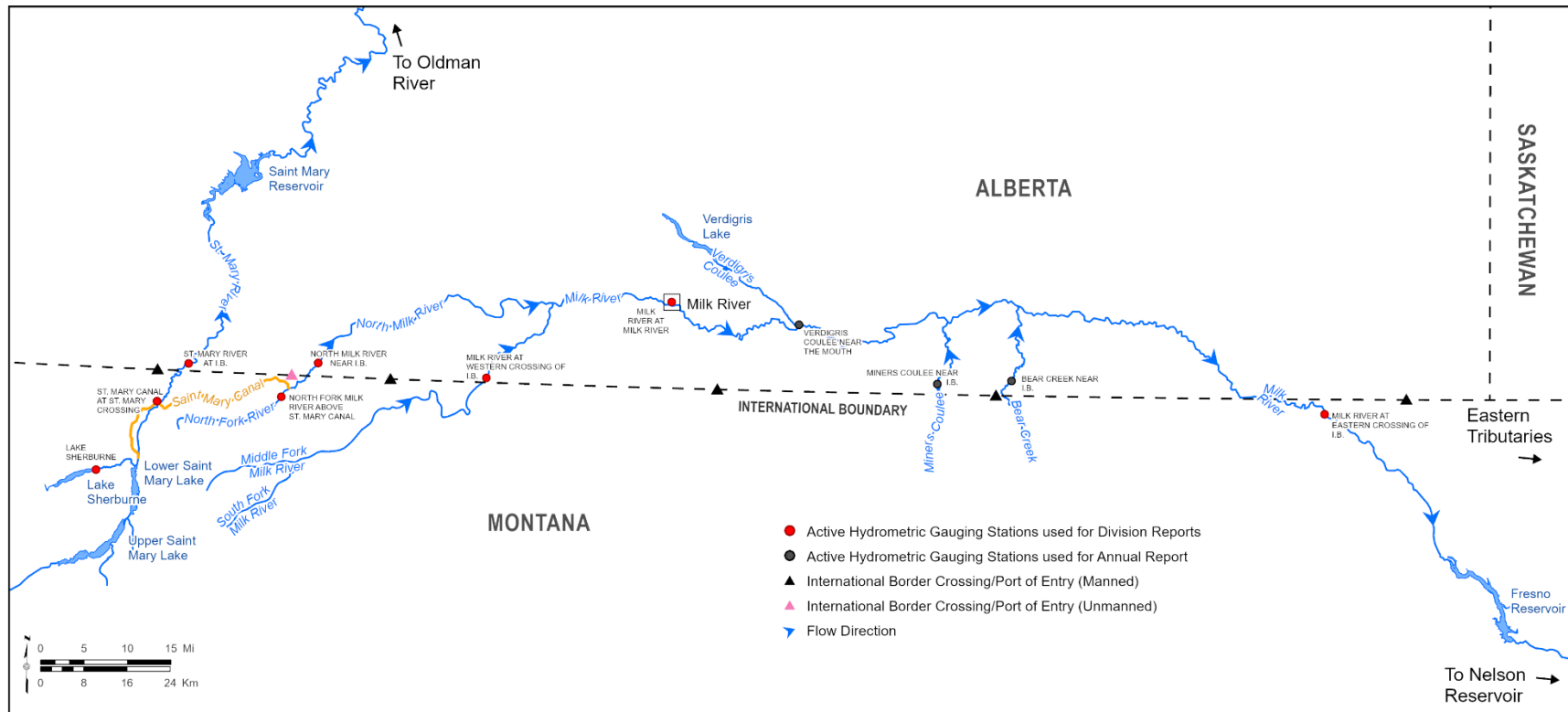


Figure 2. River flows in the St. Mary - Milk River Basin

Schematic Diagram Showing Diversion from St. Mary to Milk River Basin

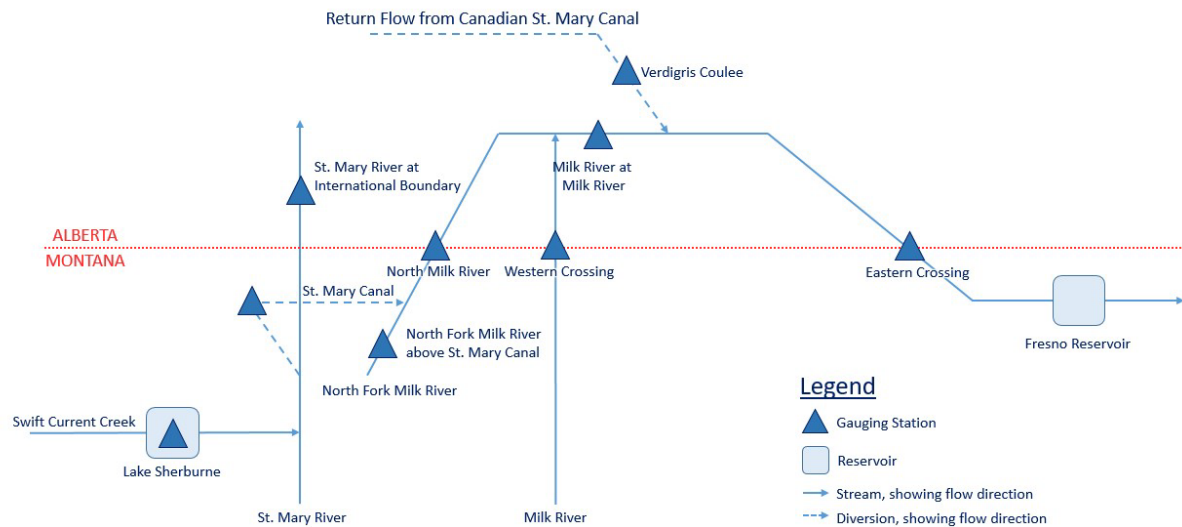


Figure 3. Flow schematic showing diversion from St. Mary River to Milk River

The US St. Mary Canal is 29 mi (47 km) long, beginning at the St. Mary Diversion Dam immediately downstream of the Lower St. Mary Lake outlet. Large siphons carry water from the canal across parts of the landscape, using gravity to transport the water downhill and uphill. A series of five concrete drop structures is used to manage the elevation change prior to discharge from the US St. Mary Canal to the North Fork of the Milk River.

At its source, the Milk River has two major tributaries, the South Fork Milk River (or Milk River) and the North Fork Milk River (or North Milk River). Before the North Fork Milk River enters Canada, it is supplemented by the St. Mary River diversions through the St. Mary Canal. Without the input from the St. Mary River, certain stretches of the Milk River can become dry during the summer months. Once in Canada, the North Milk River flows into an easterly course for about 25 mi (40 km). It then joins the South Fork River, approximately 12 mi (19 km) west of the town of Milk River, Alberta, to form the Milk River. After the confluence of the South and North Forks, the Milk River continues in an easterly direction, about 6-10 mi (10-16 km) north of the Canada-United States border, for an additional distance of about 90 mi (145 km). It then changes to a southeasterly direction and flows back across the International Boundary into eastern Montana. Fresno Dam, which is about 50 mi (80 km) downstream of the Canada-United States boundary, is the major on-stream storage reservoir on this system. Major irrigation diversions from the river begin just below Havre, MT. A number of irrigation diversion dams and pumping stations along the river supply water to agricultural lands.

The Milk River watershed includes portions of the Cypress Hills in Canada, the Sweetgrass Hills, Bears Paw Mountains and Little Rocky Mountains in Montana, and extensive prairie areas in both the United States and Canada. The tributaries of the Milk River that flow south from the Cypress Hills in Alberta and

Saskatchewan are collectively known as the Eastern Tributaries. These include the Frenchman River, Battle Creek and Lodge Creek. The scope of this study did not include the Eastern Tributaries.

1.2.2 Climate and Hydrology

The St. Mary and Milk Rivers both originate in the United States, in the mountains and foothills of Glacier National Park and the Blackfeet Indian Reservation in Montana. The Milk River watershed climate has been characterized as having short, warm summers and cold winters that may be relieved by occasional to frequent mild periods (MRWCC 2024). Winters in the mountains are cold and snowy, while summers in the mountains are cool. From the Montana mountains and foothills, the rivers cross into Alberta's moderate hills and flat prairies, where winters are typically cold, and summers are hot and dry. The mean annual precipitation decreases moving from west to east and from higher to lower elevations. Rainfall in the watershed is unevenly distributed, there is high yearly variability, and the watershed is prone to drought. More than 50 percent of the annual precipitation in the Milk River watershed occurs during the May – September growing season (MRWCC 2024).

The St. Mary and Milk Basin continues to be affected by climate change. The North Central region of Montana has experienced an average temperature increase of approximately 0.5 °F (0.3°C) each decade from 1950 to 2015, while average temperatures in Alberta are increasing between 0.9 and 1.8 °F (0.5 - 1°C) in winter and 0.2 and 0.5 °F (0.1 - 0.3 °C) in summer (MWRCC 2024). Most warming occurs in winter and spring. During the same time period, the average winter precipitation decreased approximately 0.09 in (2.29 mm) per decade (MWRCC 2024). While future predictions are uncertain, it is anticipated that average annual temperatures will continue to increase, and the timing and quantity of precipitation will shift going forward, with historically wet months likely to get wetter and summer months likely to get drier (USBR & MDNRC 2024).

Table 1 summarizes the hydrology of the St. Mary and Milk Basin. The St. Mary River watershed has a total drainage area of 1,390 mi² (3,600 km²). The St. Mary River watershed in the United States has a mean annual precipitation of 47 in (1,200 mm), most of which falls as snow. The part of the watershed in Canada is drier. The St. Mary River has a fairly regular and dependable flow during the summer months due to its source water in the high elevations of Glacier National Park. Winter flows are sustained by a groundwater base flow.

The Milk River watershed is larger than the St. Mary River watershed, with a total drainage area of 19,300 mi² (50,000 km²). The watershed upstream of the eastern crossing of the international boundary has a mean annual precipitation of 13.8 in (350 mm) and a mean annual lake evaporation of 30.3 in (770 mm). The moisture deficit categorizes the watershed as semi-arid. The Milk River has variable flows that depend on spring snowmelt and rainfall in the foothills. The Eastern Tributaries of the Milk River (named in Article VI of the Boundary Waters Treaty), including the Frenchman River, Battle Creek, and Lodge Creek, have highly variable flows that are typically low after the spring runoff.

1 **Table 1. Basin Hydrology (AMTF 2006)**

	St. Mary River	Milk River Mainstem	Milk River Eastern Tributaries
Mean annual flow volume	657,600 ac-ft (811,200 dam ³) at international boundary	126,900 ac-ft (156,600 dam ³) at Eastern Crossing	115,100 ac-ft (141,900 dam ³) combined natural flow at international boundary
Receiving system	Saskatchewan River (North)	Missouri River (South)	Milk River/Missouri River (South)
Dominant water source	Glacier/snow fed (continuous flow)	Snow/rain fed (ephemeral flow)	Snow/rain fed (ephemeral flow)

2 **1.2.3 Aquatic Ecosystems of the Basin**

3 The St. Mary and Milk rivers support distinct yet interconnected aquatic and riparian ecosystems
4 spanning a diverse range of ecotones across southern Alberta, Saskatchewan, and Montana. These
5 transboundary watersheds extend from the Rocky Mountain headwaters and foothill environments of
6 the St. Mary River to the mixed-grass prairie, semi-arid grasslands, wetlands, and riparian floodplains of
7 the Milk River. This landscape gradient creates a variety of aquatic and riparian habitats, including cold-
8 water mountain streams, prairie rivers, tributaries, side channels, oxbows, wetlands, and seasonally
9 inundated floodplains. Collectively, these habitats support diverse and interconnected food webs
10 comprising aquatic algae and macrophytes, benthic macroinvertebrates, riparian vegetation and
11 wildlife, amphibians, and a range of native and non-native fish species.

12 Aquatic ecosystem health in these basins is governed by the interaction of biological communities,
13 physical habitat, and hydrological, chemical, and ecological processes. The St. Mary River functions
14 primarily as a cold-water, higher-gradient montane system supporting sensitive benthic invertebrate
15 communities and cold-water fishes such as bull trout and westslope cutthroat trout. In contrast, the
16 Milk River is a warmer, more turbid prairie river characterized by naturally variable flows and species
17 adapted to fluctuating environmental conditions, including several native minnows and suckers.
18 Hydrologic connectivity among upland, riparian, floodplain, and aquatic habitats, together with seasonal
19 patterns of flow, sediment transport, and nutrient cycling, plays a critical role in maintaining ecosystem
20 structure and function throughout both rivers.

21 A key factor in maintaining healthy river ecosystems is ensuring that enough water remains in the river
22 at the right times of year and for long enough periods to support fish, aquatic plants, invertebrates, and
23 the natural processes that sustain them. These environmental (or ecological) flows include not only the
24 amount of water in the river, but also its timing, duration, frequency, and quality. In the St. Mary and

Milk rivers, water diversions, reservoir operations, climate variability, and growing demands for water can affect habitat availability, fish movement and reproduction, species composition, and overall ecosystem functioning. As a result, determining environmental flow is complex and requires appropriate data and knowledge and an understanding of how changes in river flows affect aquatic ecosystems over time and across different habitats and levels of the food web.

1.2.4 Socioeconomic Setting

The St. Mary and Milk Rivers support many uses and interests, such as agricultural, municipal and industrial activities, recreation, and ecosystems. The dominant agricultural use is irrigated agriculture. The types and quantities of crops grown depend on the reliability of the water supply, but cereal and forage crops dominate. Since the Milk River is substantially supported by the diversion of water from the St. Mary River, water-based activities in the Milk River watershed, including municipal use, sustaining aquatic habitat and recreation, have evolved to rely on this source of water. Without the diversion, water-related activities would be significantly reduced.

Agricultural Water Use

Agricultural water use is the dominant abstraction in the Basin and includes on-farm domestic, stock watering, and intensive livestock operation uses. The largest use is for irrigated agriculture. Application of irrigation water to crops can be measured in two ways: efficiency and duty. *Efficiency* is the ratio of water diverted from a river to water applied on fields. The efficiency of application in Montana is about 50 percent, while that in the St. Mary watershed in Alberta is about 85 percent. Over the years, loss reduction measures such as lined canals, pipelines and return flow reuse have been aimed at increasing efficiency. *Duty* is the quantity of water annually applied to a crop in the growing season and is represented as the depth of water on a field. The typical irrigation application of water in Montana and Alberta is 12 in (30 cm) and in Saskatchewan, 8 in (20 cm). This difference is the result of a variety of factors, including crop and soil types, irrigation methods, local climate and others (Patterson 2016).

There are significant differences in irrigation development both between and within the St. Mary and Milk watersheds that affect the ability of producers to receive an adequate supply of water, and therefore, their willingness to invest in irrigation infrastructure. These differences include water supply, water storage, and water licensing (Acera Consult 2023):

- Water supply: The St. Mary River originates in the high mountains of Glacier National Park, which have greater snowpack than the lower foothills of western Montana that make up the headwaters of the Milk River, so the St. Mary's water supply is generally more available and more reliable during the growing season than that of the Milk watershed. This lack of reliable supply makes producers in the Milk River watershed less likely than those in the St. Mary sub-watershed to invest in advanced irrigation infrastructure.

- Water storage: There are no storage reservoirs located on the Milk River in Alberta, so Canadian producers can irrigate only when sufficient water is available in the river. In contrast, several on-stream and off-stream storage reservoirs have been constructed in the St. Mary sub-watershed, allowing irrigation districts to store spring runoff for summer irrigation.
- Water licensing: In the St. Mary watershed, most irrigation producers are in one of the irrigation districts and have equal rights to the water. In times of water shortage, all producers in the irrigation district share the shortage equally. In the Montana portion of the Milk River watershed, most irrigators draw water from the Milk River Project, which supplies the lower Milk River valley with water for irrigation; like Alberta irrigators in the St. Mary watershed, Montana Milk River irrigators share shortages equally. In the Alberta portion of the Milk River watershed, producers have individual licenses, drawing directly from the river, that follow the “first in time, first in right” model, meaning that producers with junior (more recent) licenses experience significant uncertainty regarding their ability to divert irrigation water.

These differences mean that in the St. Mary River watershed, irrigation producers are reasonably assured of receiving an adequate supply of water to meet a majority of their irrigation needs during the growing season, whereas in the Milk River watershed, there is significant supply uncertainty. Fewer than 50 percent of the licensed irrigation area in the Milk River watershed in Alberta receives irrigation water on a regular basis, and the producers who are able to irrigate might still have their supply terminated during the growing season due to shortages. Thus, there is little incentive for producers to invest in irrigation (Acera Consult 2023). Agriculture and irrigation in each of the two watersheds are briefly summarized below, followed by a discussion of the value of irrigation water within the Basin.

St. Mary River Watershed

There is little irrigation within the US portion of the St. Mary watershed. In Alberta, irrigation water from the St. Mary River downstream from the international border is supplied through an integrated system of reservoirs, diversion structures, canals, and underground pipelines. The irrigation water is transported through approximately 1,500 mi (2,500 km) of canals and pipelines, which serve about 563,000 ac (228,000 ha) of irrigated lands (AAI, 2024). Approximately 59 percent of the canals have been converted to underground pipelines to improve water distribution and delivery efficiency and minimize soil salinity and waterlogging problems on adjacent irrigated lands (AAI, 2024).

The Raymond Irrigation District (RID) and St. Mary River Irrigation District (SMRID) support diversified irrigation production, with more than 60 different irrigated crop types grown. Crop production in the SMRID is primarily cereals (35 percent) and forages (29 percent) that support the intensive livestock feeding industry located in and adjacent to southern Alberta’s irrigated areas. Special crops such as potatoes, seed canola, sugar beets, sweet corn, dry beans, mint, and a variety of fresh vegetables also represent a substantial portion (25 percent) of irrigated production in the SMRID. In 2020, about 401,000 acre-feet (ac-ft), or 495,000 cubic decameters (dam³) of irrigation water was applied to irrigate 520,278 ac (210,549 ha) of crops in the RID and SMRID, which equates to 0.8 acre-ft/acre (2.35 dam³/ha). Irrigation producers investing in irrigation system upgrades have resulted in significant improvements in

irrigation water use efficiency, reducing the volume of water diverted from the rivers to meet crop requirements (Acera Consult 2023).

Milk River Watershed

Much of the land in the Milk River watershed remains as natural grassland, while about 30 percent of the total watershed is used as cropland, including 33 percent of the watershed area in Montana, 31 percent in Saskatchewan, and 17 percent in Alberta (Acera Consult 2023). Agricultural development in the watershed is a mix of pasture and cropland. In Alberta, agricultural production includes cereals, oilseeds, forages, natural range, and tame pasture, nearly all of which is carried out under rainfed conditions. About 8,000 ac (3,240 ha) of land is currently licensed for irrigation (Acera Consult 2023). However, previous studies have indicated that Milk River irrigators can access sufficient water to reliably irrigate only about 3,000-4,000 ac (1,200-1,600 ha) (Acera Consult 2023). The primary crops grown under irrigation in the Milk watershed are wheat and alfalfa. Similar crop varieties are grown under dryland and irrigated conditions in the Milk River watershed in Alberta.

In the United States, the US Bureau of Reclamation's Milk River Project (MRP) furnishes irrigation water to more than 140,000 ac (57,000 ha) of land in the Milk River watershed and is responsible for the vast majority of irrigation water supply within the US portion of the watershed. MRP-irrigated lands span approximately 165 mi (265 km) in Hill, Blaine, Phillips, and Valley counties.

The MRP includes the following principal features:

- Fresno Storage Dam
- Lake Sherburne
- Nelson Storage Dam
- Dodson, Vandalia, St. Mary, Paradise, and Swift Current Diversion Dams
- Dodson Pumping Plant
- More than 200 mi (320 km) of canals, 219 mi (350 km) of laterals, and 295 mi (475 km) of drains.

Irrigation districts comprise the majority (72 percent) of MRP-irrigated lands; irrigation districts and district pumpers are part of the Milk River Joint Board of Control (JBOC), which works with the US Bureau of Reclamation (USBR) to develop annual operations and maintenance plans and set annual water allotments. River pumpers (private commercial farmers holding contracts with the USBR), private land irrigators (landholders holding an individual water right with the state of Montana), and the Fort Belknap Indian Reservation (the senior water right holder for natural flow) are not party to the JBOC. Diversion allotments are set at the beginning of the irrigation season, and farmers usually use their full allotments every year. The primary irrigation season is May 1 – September 15. Since 2007, annual MRP irrigation diversions to JBOC member lands have averaged 1.75 ac-ft/ac (5.33 dam³/ha). Based on this diversion rate, it is estimated that the MRP provides approximately 245,707 ac-ft (303,200 dam³) per

year of irrigation diversions. Irrigated crops include alfalfa hay, feed barley, and irrigated pasture; dryland crops include dryland pasture, spring wheat, feed barley, and peas (WestWater Research 2024).

Value of Irrigation Water

A recent study (Acera Consult 2023) determined that irrigated crops in a representative area of the St. Mary sub-watershed generated approximately four times as much gross revenue (CDN\$2,047.30/ha) as dryland crops in the same size area (CDN\$505.93/ha). Crop yields under irrigation were roughly double the yields under dryland production, and a significantly greater proportion of higher value specialty crops are grown under irrigation. Similarly, gross on-farm revenue for livestock production under irrigation was more than ten times that of dryland production. Based on gross revenue, the value of irrigation water in the Raymond and St. Mary River irrigation districts was calculated to be CDN\$2.67/m³, which corresponds to a total annual gross economic value of approximately CDN\$1.3 billion for the land irrigated in these districts (Acera Consult 2023).

In the Milk River watershed in Alberta, even under conditions in which irrigation water is limited, gross revenue from irrigation (CDN\$906/ha) is much higher than revenue from dryland (CDN \$499/ha); when irrigation water is not limited, gross revenue is almost three times higher (CDN\$1,413) than dryland (Acera Consult 2023). Differences for livestock and eggs are even larger than for crops. Overall, when water is not limited, irrigated crops and livestock generate about CDN\$2,271/ha more than the combined gross revenue from dryland production (Acera Consult 2023). The gross economic value of the irrigation water was estimated at CDN\$0.55/m³ – CDN\$0.81/m³, depending on whether the water is limited (Acera Consult 2023).

In Canada, the gross economic value of irrigation water in the St. Mary River sub-watershed is nearly five times that of the Milk River watershed under current irrigation conditions (Acera Consult 2023).

Table 2 compares the typical gross economic value of irrigation water for a Canadian irrigation area of 8,000 acres (~3,240 ha). The significant differences in irrigation development between the two watersheds, including water availability, water storage, and water licensing, contribute to the much higher value of irrigation water in the St. Mary sub-watershed.

Table 2. Comparison of typical gross economic value of irrigation water between the St. Mary River Sub-watershed and Milk River Watershed in Canada for a 3,240-ha irrigation area (Acera Consult 2023)*

Watershed	Annual Revenue (CDN\$)	Revenue/area (CDN\$/ha)	Economic value of water (CDN\$/m ³)
St. Mary River sub-watershed	\$20,373,120	\$6,288	\$2.67 (3,292 CDN\$/ac-ft)
Milk River Watershed (assuming no limits to availability of irrigation water)	\$7,359,766	\$2,271	\$0.81 (998 CDN\$/ac-ft)
Milk River Watershed (current conditions, irrigation water regularly limited below crop requirements)	\$2,359,509	\$728	\$0.55 (678 CDN\$/ac-ft)

*Does not include Eastern Tributaries

A study (WestWater Research 2024) on the value of irrigation water in the Basin in the United States used a different methodology than the Canadian study, but also provided important economic information related to the value of irrigation water. The US study focused on the USBR Milk River Project, which is responsible for the vast majority of irrigation water supply within the US portion of the basin. The study quantified the agricultural benefits directly resulting from commercial irrigation with MRP water by calculating the difference in net returns generated by commercial agricultural operations within MRP-affected lands with and without access to MRP irrigation water. Two representative farms were modeled to simulate commercial agricultural operations under with-MRP (cropping patterns and practices of commercial farms diverting MRP irrigation water) and without-MRP (cropping patterns and practices likely implemented on commercial farms in the absence of MRP irrigation diversions) conditions. The US study found that in general, as irrigation water supply increases, net farm returns are expected to increase, although there are differences in marginal returns depending on water availability. When irrigation water is scarce, each additional unit of water is increasingly valuable. Conversely, when irrigation water is plentiful, each additional unit of water decreases in value (WestWater Research 2024). Overall, deliveries of Milk River irrigation project water (this includes both St. Mary diversion water and Milk River natural flow) to Montana's Milk River Watershed are estimated to provide the economic benefits summarized in Table 3.

Table 3. Estimated economic benefits of irrigation in the Montana portion of the Milk River watershed (WestWater Research, LLC, 2024)

	Annual Revenue (US\$)	Revenue/area (US\$/ac)	Economic Value of Water (US\$/ac-ft)
Net economic benefits	\$14.76 million	\$105	\$60-94
Additional gross revenue	\$35.80 million	\$255	\$146-228

Water Rights

The United States (Montana) and Canada (Alberta) administer the allocation and use of water under the prior appropriation doctrine, also known as western water law. The doctrine of prior appropriation, also expressed as “first in time, first in right”, was established during the early settlement of the West, mainly as the result of mining and irrigation. The system brought order and certainty to how water is allocated to users, especially in times of shortage. A senior water right holder with the earliest priority date is entitled to receive their permitted allocation, which is a definite amount for a specific period of time, before junior holders receive their allocations of water. Under the prior appropriation doctrine, each beneficial use (i.e. mining, irrigation, municipal, etc.) is administered per its priority date without regard for the type of use to which the water is being applied. The claims and adjudicated water rights are administered differently between the United States and Canada, as summarized below.

In Montana, water rights are principled on the prior appropriation doctrine, which is based on a priority date when the water was first diverted and put to beneficial use (MAJI 2009). A person or municipality planning a new development for which water must make application to the Montana Department of Natural Resources and Conservation (DNRC) for a water right, whether the source is surface water or groundwater. If the DNRC determines that water is available to be appropriated and will not impinge on existing users, a water right will be granted with limitations and conditions. As examples, the water must be put to beneficial use, not wasted; the right is granted for a specific source, point of diversion, quantified amount and rate of withdrawal, and season of use; and there is an annual reporting requirement (MAJI 2009). The Montana Water Use Act of 1973 included provisions to protect water quality, as well. For example, if a public comment and valid objection is made, an applicant is required to prove that water quality will not be adversely affected by their actions. The Act allows government agencies to make water reservations, but the priority dates do not supersede existing, much older rights. Tribal rights to water were buttressed by a 1908 decision of the United States Supreme Court that created the so-called Winters Doctrine, establishing that when the US federal government created Indian reservations, it implicitly reserved sufficient water rights to fulfill the reservation's purpose, and the priority dates for water rights are, therefore, the date each reservation was established. The

1 decision did not, however, quantify an amount nor suggest a means for determining the amount. The
2 State of Montana has established federal reserved rights and water compacts for Indigenous
3 communities to address this uncertainty. Due to water availability and appropriation concerns, the Milk
4 River watershed is closed to new water development except for that pertaining to Federal and Indian
5 Reserved Rights (MAJI, 2009).

6 The water allocation system in Alberta is based on the concept of “prior allocation,” as well, with the
7 allocation priority representing the application date for the allocation. This allocation system dates back
8 to 1894, when the Canadian government passed the North West Irrigation Act, which claimed all water
9 for the Crown and initiated a licensing system for water usage (MRWCC 2024). In Alberta, the 1999
10 Water Act enables the management of water use; the Act carried forward the system of prior allocation
11 and added provisions for licensing instream flows (MAJI, 2009). The Act also provides for water
12 assignments, allowing a licensee with senior priority to assign an allocation to a licensee with a junior
13 right to address short-term water shortages. Water licenses for surface and groundwater are
14 administered by Alberta Environment and Protected Areas, and licensees are required to report their
15 monthly and annual water use. Allocations for irrigation in both the St. Mary and Milk River watersheds
16 were capped decades ago (MAJI, 2009). In the Milk River watershed, irrigation accounts for 92 percent
17 of the water allocation from the Milk River mainstem, with about 8,000 ac (3,240 ha) of land licensed for
18 irrigation in Alberta (Paterson 2016).

19 In Saskatchewan water licenses for surface and groundwater are currently administered by the Water
20 Security Agency. Requests for water allocations for various purposes, including agricultural, industrial,
21 municipal, and in some cases, domestic use, must undergo a regulatory review and are subject to
22 licensing and conditions to ensure water resources are managed properly (Saskatchewan Ministry of
23 Environment 2025).

24 The Study Board recognized Indigenous water rights, compacts, and agreements, including US Tribal
25 water rights based on the Winters Doctrine (e.g., Blackfeet Nation Water Compact, and Fort Belknap
26 Indian Community’s Water Compact) and the water rights of Nations residing or having land in the
27 basin, but the study’s scope focused on water allocations between the United States and Canada; water
28 allocations based on rights and compacts within the United States and Canada were outside of the
29 scope of the study. However, the Study Board and staff members were educated and remained mindful
30 of Indigenous water rights as work on the study was conducted. The IJC, as a binational organization
31 created and guided by the Boundary Waters Treaty, is not part of the Canadian Crown, and accordingly
32 is not subject to, and cannot fulfill, the Crown's Duty to Consult.

33

34

1.2.5 Natural Flows and Apportionment of the Waters of the St. Mary and Milk Rivers

The apportionment of the waters of the St. Mary and Milk Rivers is governed by the [1909 Boundary Waters Treaty](#), Article VI. The BWT states:

...the St. Mary and Milk Rivers and their tributaries (in the State of Montana and the Provinces of Alberta and Saskatchewan) are to be treated as one stream for the purposes of irrigation and power, and the waters thereof shall be apportioned equally between the two countries, but in making such equal apportionment more than half may be taken from one river and less than half from the other by either country so as to afford a more beneficial use to each. It is further agreed that in the division of such waters during the irrigation season, between the 1st of April and 31st of October, inclusive, annually, the United States is entitled to a prior appropriation of 500 cubic feet per second of the waters of the Milk River, or so much of such amount as constitutes three-fourths of its natural flow, and that Canada is entitled to a prior appropriation of 500 cubic feet per second of the flow of St. Mary River, or so much of such amount as constitutes three-fourths of its natural flow.

In 1921, an [IJC Order](#) was signed to clarify the terms of the Treaty, detailing the apportionment of water from the St. Mary and Milk Rivers and their tributaries. The water rights of Indigenous Nations were not reflected in the Order. The Order specified not only the apportionment of water between Canada and the United States, but also the responsibilities and duties of the accredited Irrigation and Reclamation Officers, now known as the Accredited Officers, who are appointed by each country.

The Accredited Officers determine the daily natural flows at the border for the St. Mary, Milk, and Frenchman Rivers, and Lodge and Battle Creeks². The natural flow is defined as “the quantity of water which would naturally flow in any watercourse had the flow not been affected by human-made features” (USGS and NHS, 2024). The natural flow is, therefore, the flow that would occur without diversions, reservoirs, or consumptive uses. Each country’s entitlement and receipt for the main stems of St. Mary and Milk Rivers is tracked and reported for the irrigation season (April 1 – October 31), by calendar year. Meanwhile, entitlements and receipt for the Eastern Tributaries (Lodge Creek, Battle Creek, and Frenchman River) and all apportioned streams are tracked for the full calendar year. Figure 3 outlines the entitlements for Canada and the United States. The 2024 Procedures for the Division of the Waters of the St. Mary and Milk Rivers supplementary document provides additional details regarding the determination of natural flows and the entitlements of the two countries. Although the treaty mandates flow rate entitlements, it does not address the timing for balancing of any deficits. This allowed the Study Board to consider more flexible options, such as the modified annual balancing period described further in this report.

² The [official record of natural flows](#) is agreed to by the AOs.

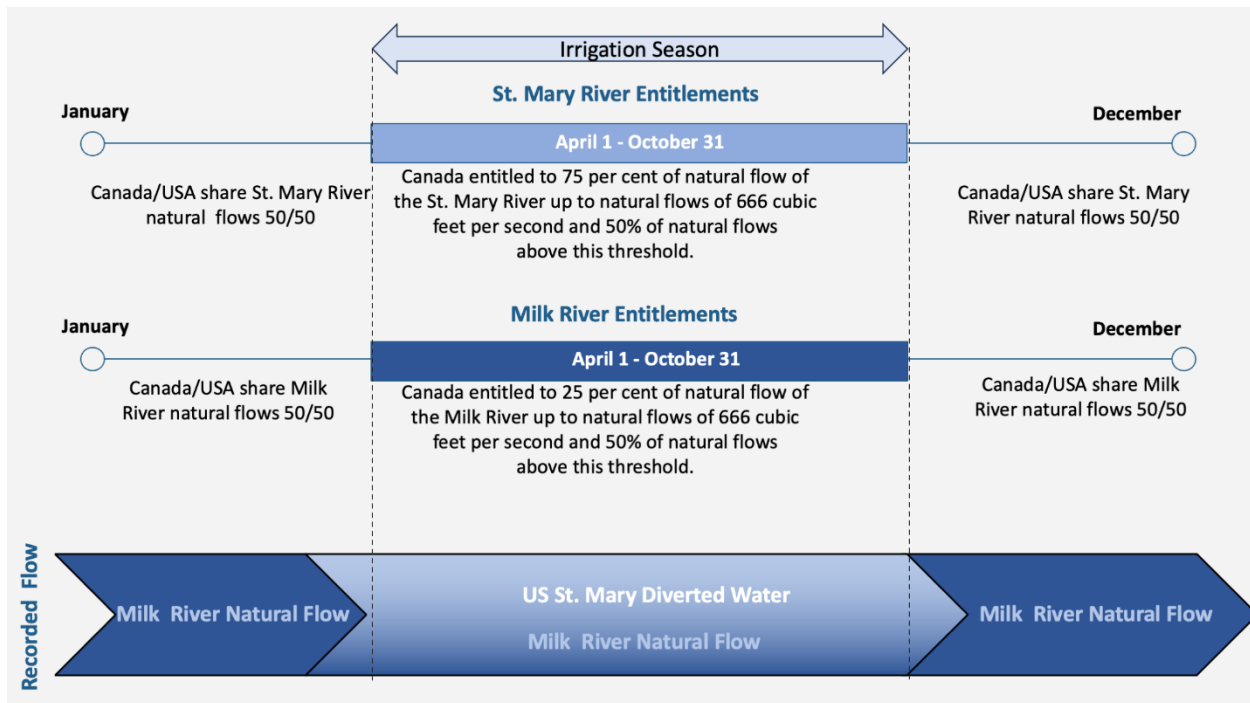
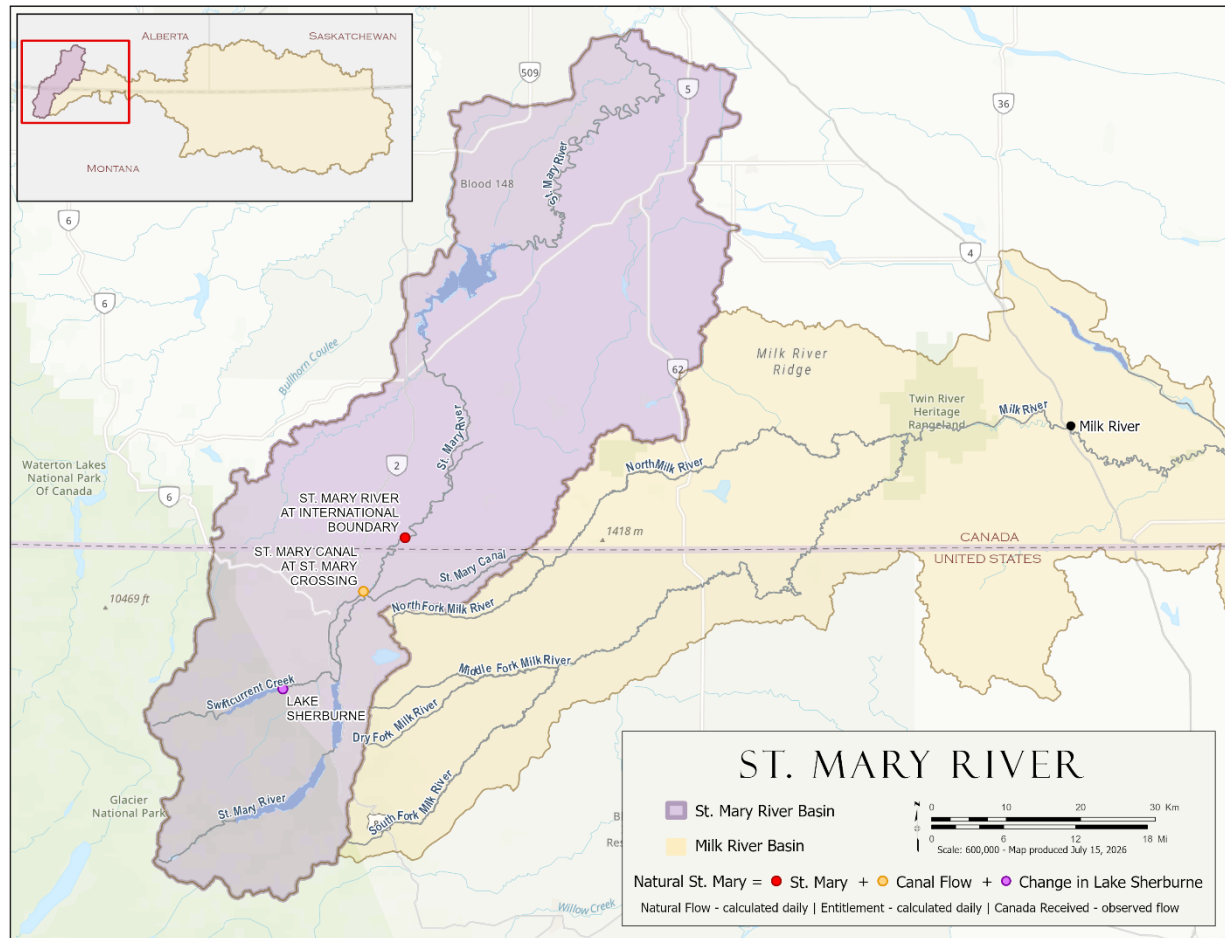


Figure 4. Water Apportionment in the St. Mary and Milk River Basins under the 1921 IJC Order

St. Mary River

The 1921 Order states that during the irrigation season (April 1 to October 31), Canada is entitled to three-fourths of the natural flow of the St. Mary River at the International Boundary when the natural flow is 666 cubic feet per second (ft³/s) (18.9 cubic meters per second, m³/s) or less (and the United States is entitled to one-fourth). Flows over 666 ft³/s (18.9 m³/s) are to be divided equally between the two countries. During the non-irrigation season (November 1 to March 31) the natural flow at the International Boundary is divided equally between the two countries.

The natural flow of the St. Mary River at the International Boundary represents the flow that would have reached Canada had it not been for human-made water diversions and use in the drainage basin. The United States constructed Lake Sherburne and the St. Mary Canal, and the effects of these features must be accounted for in the natural flow computations. In very general terms, the natural flow of the St. Mary River at the International Boundary is computed from the recorded discharge for the St. Mary River at the International Boundary, adjusted for human interventions, primarily storage or release at Lake Sherburne and the diversion into the St. Mary Canal (Figure 5).



1 **Figure 5. Schematic of St. Mary River natural flow estimation**

2 The governing equation for calculating the natural flow is:

3 ***Natural St. Mary = St. Mary @ International Boundary + Canal Flow + Change in Lake Sherburne***

4 Lake Sherburne operations affect natural flow because water stored reduces flow, while releases
 5 augment it. A one-day lag is applied to account for travel time between the reservoir and the
 6 international boundary. Evaporation from Lake Sherburne is considered negligible and has been
 7 excluded from calculations since 1983. Recorded flow is obtained from the St. Mary River at
 8 International Boundary gauge (USGS 05020500, ECCC 05AE027) and also, reservoir level change on Lake
 9 Sherburne (USGS-05015500) and flow into the canal (USGS-05018000).

10 *Milk River*

11 The natural flows of the Milk River are divided in accordance with the 1921 Order. The Order states that
 12 during the irrigation season (April 1 to October 31), the United States is entitled to three-fourths of the
 13 natural flow at the Eastern Crossing of the International Boundary when the natural flow is 666 ft³/s
 14 (18.9 m³/s) or less. Flows in excess of 666 ft³/s (18.9 m³/s) are divided equally between the two

countries. During the non-irrigation season (November 1 to March 31), the natural flow at the eastern crossing of the International Boundary is divided equally between the two countries.

The natural flow of the Milk River at the Eastern Crossing of the International Boundary is defined as the flow that would have reached the United States had it not been for human-made water diversions and use in the drainage basin. The Milk River natural flow computation is more complex than the St. Mary River computation because of St. Mary Canal diversions into the Milk River, consumptive uses for irrigation and municipal use in both the United States and Canada, and evaporation losses.

The calculation, summarized in Figure 6, uses the following equations:

$$\text{Natural Eastern} = \text{Measured Eastern} + \text{Consumptive Use} - \text{Canal Impact}$$

$$\text{Canal Impact} = \text{North Milk @ International Boundary} - \text{North Fork above Canal} - \text{Increase in Evapotranspiration}$$

where Natural Flow at the Eastern Crossing is simply the measured flow at the Eastern Crossing, with the addition of any water used for irrigation in Canada (Consumptive Use) and the impact of the diversion canal (Canal Impact) removed.

The impact of the canal is estimated as the measured flow for North Fork Milk River at Western International Boundary Crossing, subtracting the flow above the diversion to estimate the natural flow at the Western Crossing. These flows are lagged five days to account for travel time to the eastern crossing; and the increase in evaporation is the incremental evapotranspiration loss due to increased surface area from diversions. The 2024 Procedures for the Division of the Waters of the St. Mary and Milk Rivers supplementary document provides further detail on the computations.

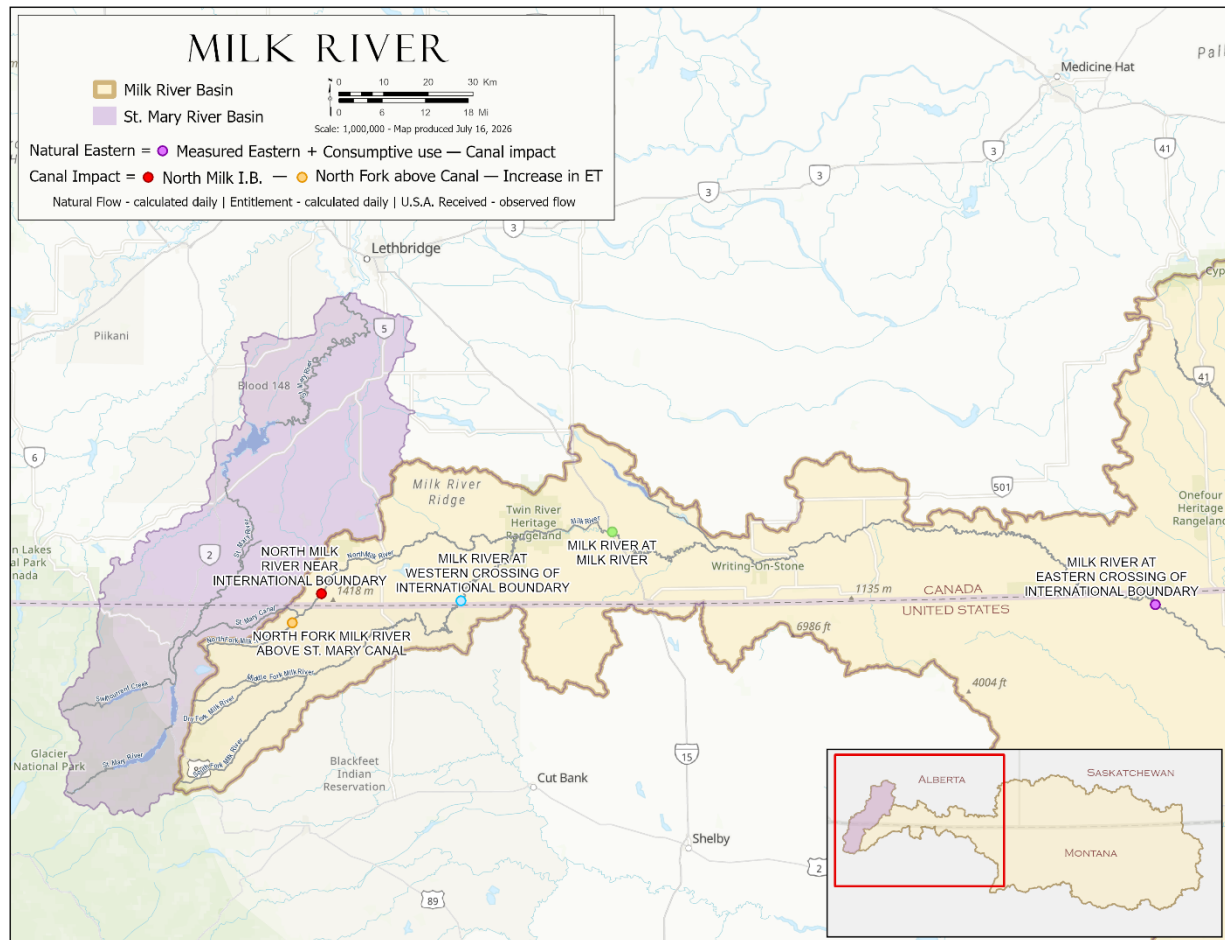


Figure 6. Schematic of natural flow calculations for the Milk River Watershed

Eastern Tributaries of the Milk River

The waters of the Eastern Tributaries of the Milk River are divided in accordance with the 1921 Order, which stipulates that “The natural flow of the eastern (otherwise known as the Saskatchewan or northern) tributaries of the Milk River at the points where they cross the International Boundary shall be divided equally between the two countries.” (IJC 1921).

Prior to 1937, Canadian water use along the Eastern Tributaries consisted of domestic projects, and the Canadian share of the natural flow was considered low enough to not account for it. However, after the construction of dams and reservoirs on the Frenchman River, Lodge Creek, and Battle Creek, accounting was considered necessary. At present, the waters of Lodge Creek, Battle Creek, and Frenchman River are divided equally between the two countries. These streams begin in the Cypress Hills area of southeastern Alberta and southwestern Saskatchewan and flow in a southeasterly direction to join with the Milk River in Montana. The remaining major tributaries - Woodpile, East Fork Battle, Lyons, Whitewater, Rock, and McEachern Creeks - presently do not have sufficient usage in Canada to warrant a division of flow.

Balancing

From March³ 1 to October 31, when stream gauges are operating, twice-monthly computations are made by the AOs to determine each country's share of the flow. These twice-monthly computations to determine natural flows, entitlements, receipt, and deficits are referred to as division periods or balancing periods. Balancing periods are 15 or 16 days.

A deficit occurs when the downstream country does not receive its entitlement; in such cases, the deficit is to be repaid in the subsequent balancing period. As mentioned above, the Treaty does not specify when any deficits should be repaid. The AOs' Letter of Intent (LOI) is the current administrative or flexible balancing option. The LOI allows the United States to incur a deficit to Canada on the St. Mary River in the March-May period each year, and Canada to incur a deficit to the United States on the Milk River in the June-September period (AO, 2001). The maximum US deficit is 4,000 ft³/s-days (7,900 acre-feet, 9,800 dam³) on the St. Mary River between March 1 and May 31, which may be reduced to 2,000 ft³/s-days (4,000 acre-feet, 4,900 dam³) by July 15. The maximum Canadian deficit is 2,000 ft³/s-days (4,000 acre-feet, 4,900 dam³) on the Milk River between June 1 and September 15. Surplus deliveries are not credited, and any outstanding deficits as of September 15 can be offset between the two rivers and must be equalized by October 31.

Additional information on apportionment, measurement, and calculation of water within the St. Mary and Milk River Basin is available in the 2024 Procedures for the Division of the Waters of the St. Mary and Milk Rivers supplementary document and in a video located on the Accredited Officers' [website](#).

Historical Apportionment

Application of the apportionment provisions of the 1921 Order results in a specific amount of water being identified as each country's apportioned amount or "entitlement". In practice, the amount of water received by the upstream country has been less than its entitlement. The upstream country's receipt is what it actually uses or accesses. The downstream country receives what the upstream country doesn't access. A 2006 report by the International St. Mary – Milk Rivers Administrative Measures Task Force (AMTF 2006) noted that under the existing Administrative Procedures and current level of infrastructure within the basin, the United States has not been able to fully access its entitlement of St. Mary River flows, and Canada has not been able to access its entitlement of Milk River flows (this does not include the Eastern Tributaries). An analysis of data from 1950 through 2004 (AMTF 2006) indicated that the United States has accessed, on average, 62 percent of its entitlement of the St. Mary River annual volume, while Canada has accessed, on average, 25 percent of its entitlement of the Milk River annual volume (Figure 7). The Administrative Measures Task Force report provides several reasons why each country is unable to access its annual entitlement, including lack of infrastructure to store and divert entitlements, which vary throughout the year.

³ Although the irrigation season does not begin until April 1, the current AO procedures include flow computations in March when a diversion from the St. Mary River into the St. Mary Canal occurs (USGS and NHS, 2024)

These long-standing challenges in accessing entitlements prompted the request for a study to identify potential changes in procedures and infrastructure that might improve each country's ability to access its entitlements.

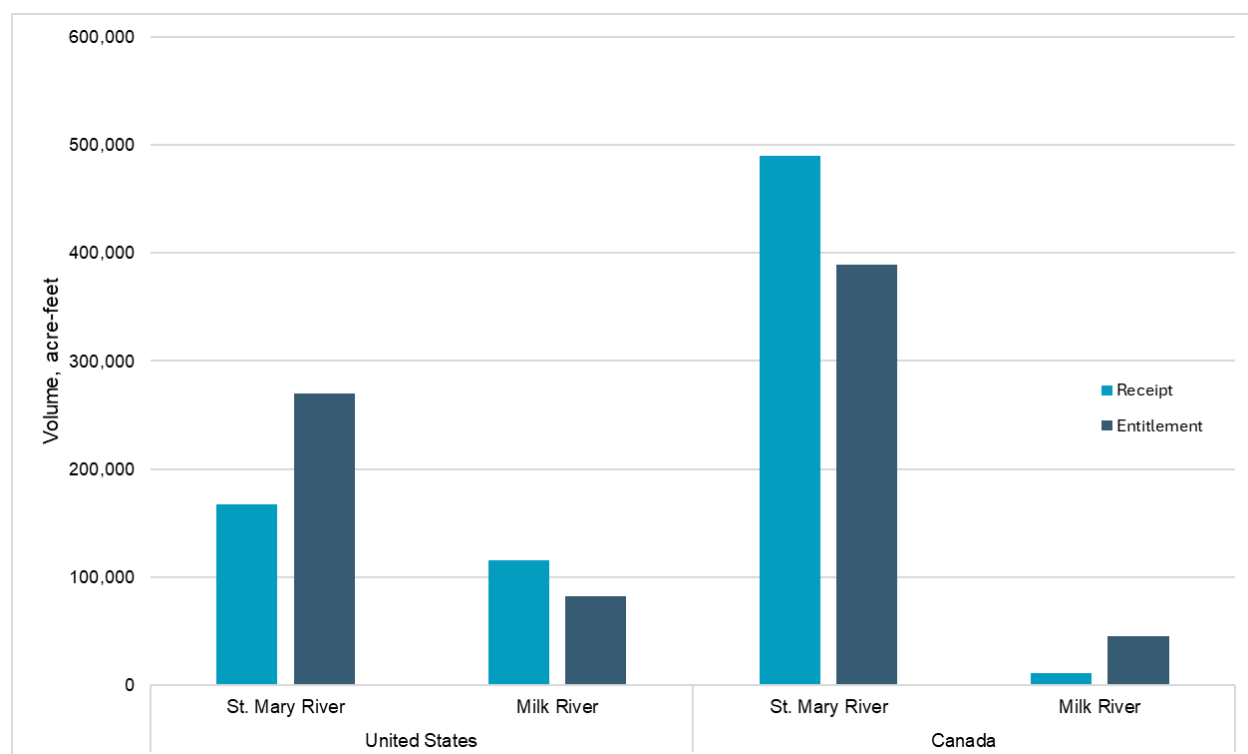


Figure 7. Average annual receipt of water entitlement from the St. Mary and Milk Rivers by the United States and Canada, 1950-2004 (based on AMTF 2006)

1.2.6 Scope

The scope of this study was defined by the IJC's 2021 Directive to the Study Board. The goal of the study was to identify and recommend to the IJC structural and non-structural (administrative) options and combinations thereof to improve each country's access to its water entitlement. The Board considered the effects of recommended options on the socioeconomics and aquatic ecosystems of the basins and incorporated Indigenous perspectives and climate change considerations in its evaluations.

The Study Board acknowledges that a significant amount of important work occurred during previous studies, including the Montana-Alberta Joint Water Management Initiative, an effort among water users and government officials in both jurisdictions to engage in a collaborative dialog to recommend improvements that would increase access to the shared waters. The IJC recognized that this past effort provided a good starting point for the new study to be undertaken by the Study Board and the options that were considered feasible to implement formed the basis for the initial options considered under this study.

The Study Board, however, was not limited to the options considered or deemed feasible by the Joint Initiative Team (JIT). A greater breadth and scope of possible options were considered by the Study

Board. The options that were considered, singly or in combination, can be broken down into two categories: structural and non-structural (administrative) options. Structural options require building or restoring infrastructure and the participation of federal/state/provincial governments to evaluate, fund, and implement. Examples include St. Mary Canal improvement, Lower St. Mary Lake storage improvement, Canadian Milk River storage, and Canadian conveyance alternative. Non-structural (administrative) options (i.e., changes in water management administrative procedures), are largely within the authority or control of the Accredited Officers for the St. Mary and Milk River Basin. Examples include modified balancing periods and capped credit systems.

As with many past efforts in the basin, efforts were focused on the St. Mary and Milk Rivers. Some of the study's findings may have implications for the Eastern Tributaries of the Milk River, so the entire system needed to be considered. However, the analysis and option formulations in this study focused on deliveries of water on the St. Mary and Milk Rivers down to the first major reservoir on each river, the St. Mary and Fresno Reservoirs, respectively.

The Study did not evaluate water-sharing allocations within each country, nor recommend changes to current domestic (federal, Indigenous, state, provincial, regional) water-sharing agreements, rights, or frameworks.

As with any large, multi-year effort, this study represents a particular point in time and was conducted in accordance with a work plan developed at the outset. Events that happened during the course of the study, such as the June 2024 failure of the St. Mary Canal siphons, while important in the context of apportionment, were not explicitly addressed.

1.3 Report Organization

The report is organized into the following sections:

Section 1 presents an overview of the St. Mary and Milk River basins and the scope of the Study.

Section 2 outlines the objectives, organization, methodology, and modelling process of the Study.

Section 3 outlines the engagement and outreach component of the Study.

Section 4 presents the structural, non-structural (administrative) options and combinations of options for modelling consideration.

Section 5 presents the results of the water management modelling.

Section 6 summarizes the Study Board's recommendations.

2 ST. MARY AND MILK RIVER STUDY

2.1 History of Water Apportionment

In the late 1800s, pressures to develop farms and industry in the border region between Canada and the United States led to increased disputes over the waters shared by the two nations. The desire by both countries to share a reliable supply of water for agricultural and ranch lands in southern Alberta and northern Montana led in part to the signing of the Boundary Waters Treaty (BWT) in 1909 and the creation of the IJC to help governments manage shared waters. Figure 8 summarizes significant events in the history of water apportionment in the Basin.

Article VI of the BWT provides a framework for measuring and apportioning flows from the St. Mary and Milk Rivers and their tributaries. The Article states that the two rivers “are to be treated as one stream for the purposes of irrigation and power, and the waters thereof shall be apportioned equally between the two countries, but in making such equal apportionment more than half may be taken from one river and less than half from the other by either country so as to afford a more beneficial use to each.” Questions soon arose on exactly how to interpret Article VI after the BWT was signed and led to a series of legal and public hearings between 1915 and 1921. Some of the disagreements included:

- the location where flow apportionment should be determined,
- the interpretation of prior appropriation language, and
- Indigenous water rights (AMTF 2006).

Therefore, following the completion of the US St. Mary Canal in 1915, the IJC found it necessary between 1918 and 1921 to issue annual orders to what are now referred to as the “Accredited Officers” (AOs) specifying each country’s water entitlements. The AOs are designated managers, one from the United States Geological Survey (USGS) and one from the Water Survey of Canada, now the National Hydrological Service of Environment and Climate Change Canada (ECCC). The general duties of the AOs are to:

- Determine daily natural flows at the border for the St. Mary, Milk, and Frenchman Rivers and Lodge and Battle Creeks.
- Determine the amount of water in these streams to which each country is entitled and communicate this information to interested parties.
- Operate the irrigation works of either country to facilitate the use of its share of the waters.
- Report measurements at international gages and any disagreement between the AOs to the IJC.

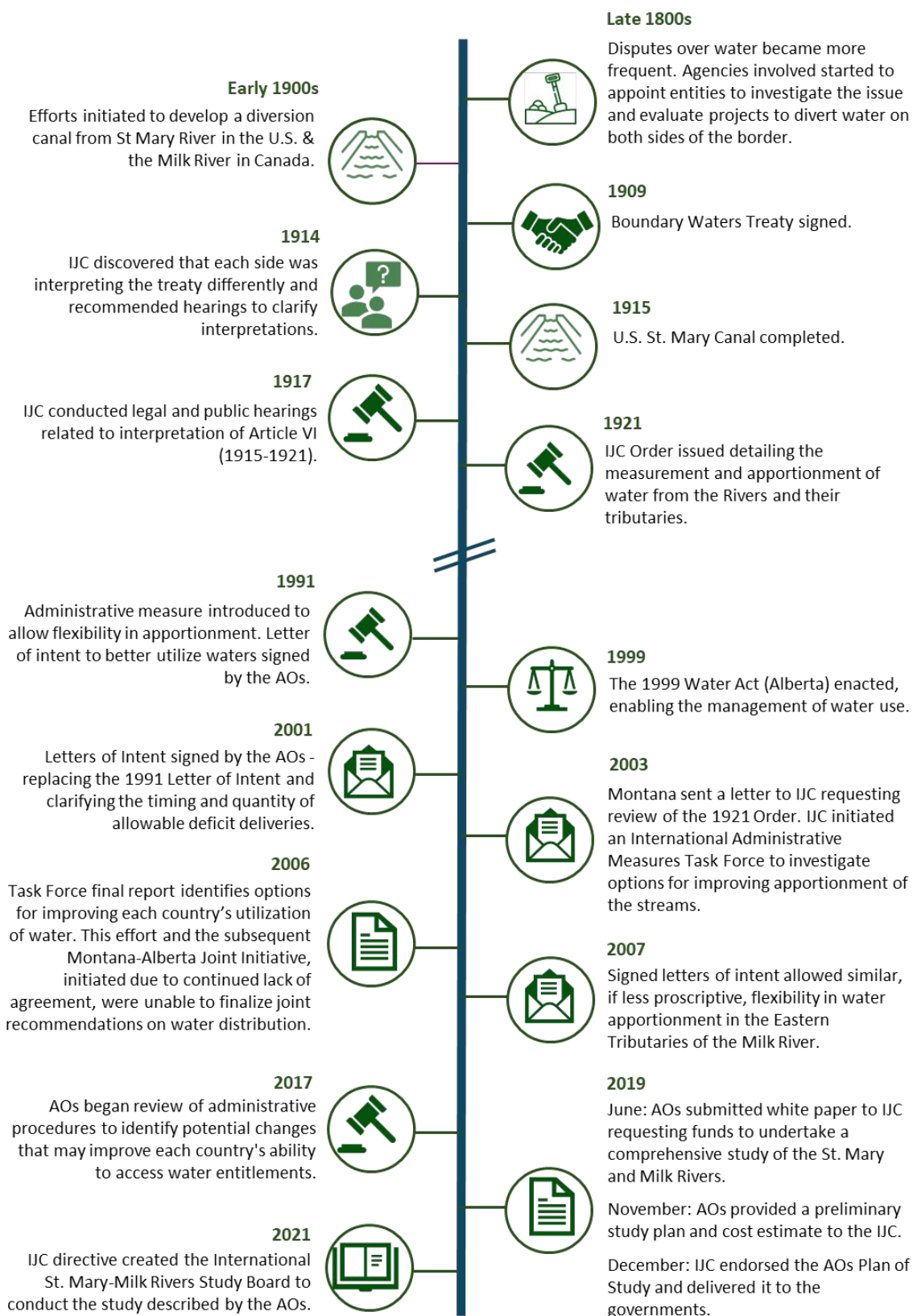


Figure 8. Major developments in St. Mary and Milk River water apportionment between Canada and the United States

2.1.1 1921 Order

When Lake Sherburne became operational in 1919, a low-flow year, the IJC directed the AOs to seek some compromise in how the waters were to be apportioned, but the AOs were unable to do so because US and Canadian interests were not aligned (AMTF 2006). Consequently, in March 1921 the IJC issued a new order (henceforth known as the “1921 Order”) with specific instructions on how waters were to be measured and apportioned into the future. For the last 100 years, the 1921 Order has been the primary guiding document for apportioning flows in these watersheds.

The 1921 Order clearly described each country’s entitlement, including prior appropriations as well as the location where flow apportionment should be determined. Despite its clarity on broad issues, the 1921 Order lacked the detailed information required by the AOs to operationally apportion water.

2.1.2 Administrative Procedures

Since the 1921 Order was issued, the AOs developed “administrative procedures” that were eventually codified beginning in 1979 into an “Administrative Procedures Manual.” The Manual is periodically reviewed and has been updated as needed over the years. The manual includes such details as:

- a set of equations used to calculate the natural flow for each stream, which is a critical step in determining each country’s entitlement;
- a procedure for reporting daily natural flows on a twice per month basis, which came to be known as the “balancing period;” and
- a set of rules for refunding deficits when one country was determined after the fact to have diverted more than its entitlement, to be restored in the next balancing period or as mutually agreed by both countries (AMTF 2006).

By the late 1980s, the Milk River natural flow equation had become a sophisticated natural flow model. Continuous improvement of the Milk River natural flow model resulted in many updates to the Administrative Procedures Manual in subsequent years. These procedures are posted on the AOs’ [website](#).

2.1.3 Letters of Intent

Recognizing that the 1921 Order might not always allow the most beneficial use of the water in these watersheds, the AOs, under their authority from the 1921 Order, in 1991 and again in 2001 signed LOIs allowing for mutually beneficial use. Historically, natural St. Mary River flows are low prior to receiving mountain runoff (typically around June), while natural Milk River flows are very low in the late summer. The LOIs maintain and respect the 1921 Order but allow each country to temporarily access more of its entitlement during seasonal low flow periods, with rules for repayment later in the season. The United States is allowed to access more than its entitlement of St. Mary River water in the spring, while Canada is allowed to access more than its entitlement of Milk River water in the summer, provided that the

generated deficits are balanced or offset at the end of irrigation season. These LOIs were incorporated in the Administrative Procedures Manual after their adoption.

Another LOI signed in 2007 allowed similar, if less proscriptive, flexibility in water apportionment in the Eastern Tributaries of the Milk River. Specifically, this LOI allowed Saskatchewan and Montana to manage deficit deliveries in these streams, with the approval of the Accredited Officers, to increase or maximize beneficial use for water users in both countries.

2.1.4 St. Mary/Milk Rivers Administrative Measures Task Force and Montana-Alberta Joint Initiative

The AOs developed and codified procedures to implement the 1921 Order. However, over time, various US interests, including the US Federal Government and the State of Montana, continued to note the inequity of the 1921 Order based on their interpretation of Article VI of the BWT, and sought to revisit or reopen the 1921 Order. In each case, the IJC did not agree to reopen the Order. In response to a 2003 letter from Montana to the IJC requesting a review of the 1921 Order, the IJC held a series of public meetings and formed the St. Mary / Milk Rivers Administrative Measures Task Force. The Task Force's examination of historical records determined that from 1950-2004, the United States received more than its annual entitlement of water from the Milk River, while Canada received more than its annual entitlement of the St. Mary River, as shown previously in Figure 7. Overall, the net effect is an annual differential of nearly 43,000 acre-feet, or 53,000 cubic decameters (dam³) in favor of Canada. The annual differential is generally larger during wet/high-runoff years and smaller during drought/low water years. The Task Force's final report noted "a strong desire by both countries to maintain (within their respective entitlements) some minimum instream flow at the international border for environmental and channel maintenance purposes." (AMTF 2006). However, the Task Force issued its final report in 2006 without identifying a mutually acceptable means for the United States and Canada to increase their access to water entitlement shares.

The IJC suggested Montana and Alberta work with the AOs to explore the issues further. In response, Montana and Alberta established the Montana – Alberta Joint Initiative on the Sharing of Waters of the St. Mary and Milk Rivers to "review the current situation and make recommendations to the two governments on options to increase the ability of each jurisdiction to better access the shared waters of the St. Mary and Milk River systems." (MAJI 2009). Notably, this effort did not include the AOs, which limited the options the Joint Initiative could consider for resolving the longstanding issues in these basins. The Joint Initiative produced some excellent background reports and modelled the effect of many potential changes in procedures and infrastructure on water apportionment. However, similar to the earlier Administrative Measures Task Force, Montana and Alberta were unable to mutually agree on options that significantly improved each country's ability to access its water entitlement.

The Administrative Measures Task Force final report (2006) identified many technical improvements that the AOs could undertake to improve the accuracy of flow measurement and natural flow calculations, and therefore the accuracy of water apportionment. Over the following decade, the AOs made all those suggested changes. During a final review of the Administrative Measures Task Force

Report in 2017, the AOs noted that according to the Task Force final report, the AOs' own administrative procedures limited each country's ability to access its full water entitlement. Notably, "The U.S. entitlement of the combined flows of the St. Mary and Milk River (including Eastern Tributaries) is 45%, but it historically has received (or diverted) 41%." (AMTF 2006). Limitations in infrastructure and current administrative procedures were identified as the likely causes of this difference.

Consequently, in 2017, the AOs began a review of their administrative procedures to identify potential changes that might improve each country's ability to access its water entitlements. As part of this review, the AOs reviewed the modelling of the Joint Initiative, which included administrative, procedural, and water infrastructure changes. The final white paper review was provided to the IJC in June 2019, along with a letter noting that the best opportunity to improve water access in these watersheds was likely an unidentified and untested combination of changes in infrastructure and administrative procedures. The AOs noted the need for further investigation; the need for meaningful engagement with the public, rights holders and basin stakeholders (all with basin water interests); and their own lack of resources, and subsequently requested the IJC provide funds to undertake a comprehensive study to accomplish the tasks discussed in the white paper. The IJC endorsed this request and asked the AOs to provide a study plan and cost estimate. The IJC also asked that the study plan include an assessment of the socioeconomic effects of any proposed changes and requested that extensive Indigenous engagement be undertaken as part of the study. The AOs provided a preliminary study plan and cost estimate to the IJC in November 2019; this plan was endorsed by the IJC and both governments. On November 10, 2021, the IJC issued a Directive to the International St. Mary-Milk Rivers Study Board to conduct the study described by the AOs.

2.2 AO Plan of Study and November 10, 2021 IJC Directive

In November 2019, the AOs prepared a Plan of Study titled "The St. Mary and Milk River Apportionment Procedures Review – Project Considerations" that recommended further study of structural and non-structural options, and combinations thereof, to improve access to entitled waters for Canada and the United States. The AOs recommended the following structural options be studied:

- **St. Mary Canal Improvement:** bi-national investigation of rehabilitation of the US St. Mary Canal to at least the original capacity of 850 ft³/s (24.1 m³/s), while modelling the risks and benefits of increasing the canal size beyond its original capacity.
- **Lower St. Mary Lake Storage Improvement:** further investigation of adding storage in the upper St. Mary River watershed, in conjunction with many of the non-structural options.
- **Canadian Milk River Storage:** further investigation of adding capacity to store water in the Canadian portion of the Milk River to enable Canada to access more of its entitlement and reduce the surplus of water to the United States, in conjunction with non-structural options.
- **Canadian Conveyance Alternative:** evaluation of an additional canal or pipeline in Alberta to move water from the St. Mary River basin to the Milk River basin to increase the volume of St. Mary water moved into the Milk River for users in either Canada or the United States.

The AOs recommended the following non-structural (administrative) options be studied:

- **Modified Balancing Periods:** consider further study of modified balancing periods with other structural or non-structural options.
- **Deficit Trading – Letter of Intent:** consider further study of allowing offsetting deficits between the St. Mary River and the Milk River with the intent of maximizing benefits in conjunction with other structural and non-structural options.
- **Capped Credit System:** consider further study of allowing credits to be accumulated and used over the water year (Nov. 1 to Oct. 31) with other structural and non-structural options.
- **1921 Order Re-visited:** re-visit the Order in consideration of a changing climate, changing prior appropriation amounts, revising shares of water at different flows, and re-evaluating the definition of irrigation season due to climate change.

The AOs delivered the Plan of Study to the IJC and requested that the IJC assist in conducting the study. In December 2019, the IJC endorsed the AOs' Plan of Study and delivered it to the governments, recommending that they fund the study. In June 2021, the governments sent a letter of support to the IJC to conduct the Plan of Study.

On November 10, 2021, the IJC issued a Directive, establishing the International St. Mary and Milk Rivers Study Board. The Study Board was tasked with assisting the IJC in conducting the 2019 Plan of Study and making recommendations to improve each country's receipt of their water entitlement. The SMMRSB Directive (a supplementary document) specifies the duties and functions of the IJC and the Study Board in accomplishing the Study. The IJC's responsibilities include establishing a Government Forum working group and an Independent Review Group, and coordinating resource contributions from the two governments to support the Study Board's activities.

The Study Board's duties include:

- providing options and recommendations for the IJC's consideration;
- working by consensus toward solutions that are mutually beneficial to both countries;
- providing a workplan to the IJC and keeping the IJC informed of its progress;
- appointing two study managers (one from each country) to assist the Study Board in delivering on its mandate and establishing work groups and advisory bodies needed to carry out its work;
- carrying out outreach activities and involving Indigenous people and the public in its work to the fullest extent possible; and
- providing the IJC with its final report, including findings, conclusions, and recommendations. The IJC will review the report and may make recommendations to the governments of Canada and the United States.

2.3 St. Mary and Milk Rivers Study Objectives

The goals of the study were accomplished by achieving two broad objectives:

1. **Modelling changes to administrative procedures and infrastructure.**
2. **Evaluating the possible effects of such changes on socioeconomics and aquatic ecosystems of the Basin, incorporating Indigenous perspectives and the effects of climate change.**

Each objective was addressed as summarized below.

2.3.1 Modelling Changes to the Administrative Procedures and Infrastructure

The Canadian model developed under the Montana-Alberta Joint Initiative and a US model developed by Montana DNRC and the USBR were both used as a starting point for the water management modelling effort for this study; however, each model required significant and lengthy updates stemming from new data sets, as well as new options and scenarios. The water management models enabled the analysis of different infrastructure options (storage and conveyance) as well as changes in administrative procedures. These model revisions required extensive consultations and collaboration with model developers on both sides of the border, including the Province of Alberta, US Bureau of Reclamation, and consultants familiar with the US Bureau of Reclamation model. Climate data sets were also assembled to examine possible changes to the hydro-climatic system into the future. One potential future climate was evaluated with the most promising structural and non-structural scenarios to examine the resiliency of these scenarios to a potential future climate and was modelled with the US Bureau of Reclamation model.

2.3.2 Evaluating the Possible Effects of Changes

The Study included an historical analysis of water availability, apportionment, and irrigation within the watershed, including examination of the responses and mitigation measures adopted by water users during periods of drought or limited water availability. A socioeconomic analysis provided context for model evaluations and the development of performance indicators to evaluate the potential changes in infrastructure and administrative procedures. This work was designed as a descriptive socioeconomic assessment aimed at characterizing existing social and economic conditions within the study area. More detailed analyses, including socioeconomic impact assessment, distributional analysis, and economic valuation, were beyond the scope of the present study due to limitations in available resources, data, and project timelines.

Performance indicators (PIs) in this Study assess the effects of changing water availability on a particular interest, such as impacts on socioeconomic and aquatic habitat interests. PIs were used to compare various scenarios of structural and administrative options to a base case scenario. Outputs from models provided values for streamflow, reservoir elevations, diversions, evaporation, and evapotranspiration throughout the year. Specific performance indicators used in this Study are described later in the report (sections 2.6.1 and 4.5).

2.4 Study Governance and Organization

This Study was led by a Board of six (6) people appointed by the IJC in November of 2021: three members from Canada and three from the United States. Board members are listed in Table 4. The Board was co-chaired by the Accredited Officers for the St. Mary and Milk River Basin at the time the study began, Dr. Alain Pietroniro and Mr. John Kilpatrick, who have expert knowledge of water measurement and apportionment in the watershed. Dr. Pietroniro subsequently moved on to the University of Calgary and is no longer the Accredited Officer for Canada but remained the Study Co-Chair for Canada. Two (2) Study Managers, one from Canada and one from the United States, worked under the direction of the Study Board to assist in delivering on its mission.

Table 4. Study Board Membership

Members from Canada	Members from the United States
Dr. Alain Pietroniro (Study Co-Chair) University of Calgary (Professor), ECCC (retired) and former CAN Accredited Officer	Mr. John Kilpatrick (Study Co-Chair) US Geological Survey (retired), US Accredited Officer
Dr. Dena McMartin Vice-President (Research), University of Lethbridge	Mr. Mark T. Anderson US Geological Survey (retired), Adjunct Faculty, South Dakota School of Mines, Owner, Anderson Hydrology Consulting, LLC.
Mr. Laurie Tollefson, PAg, VPH ICID	Ms. Sue Lowry Owner, Avocet Consult, LLC; Chair, Red River Compact Commission
FM (Malcolm) Conly (Alternate Co-Chair) ECCC/NHS (retired)	Melissa Schaar (Alternate Co-Chair) Acting Director of Wyoming-Montana and Dakota Water Science Centers, USGS and Field Representative of the US Accredited Officer

While the Study Board is the focal point of this important binational initiative, the Study had several key committees and advisory groups that were critical to its success (Figure 9):

- **Government Forum** – A working group including members from federal, Indigenous, state, and provincial governments having a direct interest in water apportionment and/or St. Mary and Milk River basin infrastructure;
- **Operations Formulation and Evaluation Group (OFEG)** - A working group responsible for overseeing and coordinating the work done by the Technical Working Groups

- **Technical Working Groups (TWGs)** – Six TWGs were established to conduct the Study’s technical work. Each TWG included co-chairs, members, advisors and observers who are experts in hydrology; climate change and adaptation; socioeconomics; infrastructure; water apportionment; aquatic ecosystems; and the formulation and evaluation of options;
- **Public Advisory Group (PAG)** – including members from non-governmental organizations, resource agencies and the public;
- **Indigenous Advisory Group (IAG)** – including members and interested observers from Indigenous Nations (First Nations, Métis Nation, Tribes) residing or having land in the basin; and
- **Independent Review Group (IRG)** – A group of experts who carry out independent technical reviews of study materials.

Additional information about these key groups and their responsibilities is provided in Fact Sheet supplementary documents; a list of each group’s participants is provided in the Study Participants supplementary document.

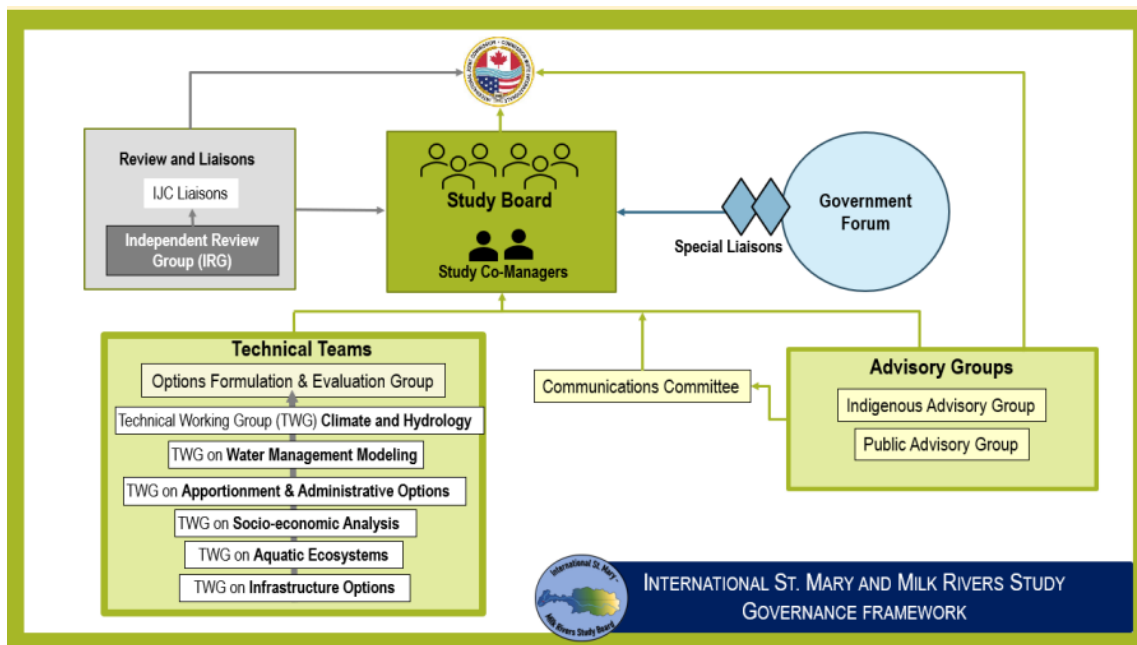


Figure 9. St. Mary-Milk River Study governance framework

2.5 Study Approach

Fulfilling the goals of the study entailed the following activities :

- Characterize historic water use and water availability in the study area;
- Develop combinations of potential changes in administrative procedures and infrastructure for simulation;
- Develop updated hydrologic and water management models to evaluate water availability under various climate and apportionment scenarios;
- Describe the socioeconomic and ecological effects of the scenarios; and
- Recommend to the IJC the preferred combination(s) of changes in administrative procedures and/or infrastructure that will improve each country's ability to access its share of water from these basins.

The Study developed Performance Indicators (PIs, Section 4.5) to measure and communicate the effects of the structural and non-structural options being examined. The PIs were developed in coordination with input from advisory groups, public meetings, and stakeholders.

2.5.1 Technical Oversight & Coordination (OFEG)

The Options Formulation and Evaluation Group (OFEG) provided technical oversight for the Study by coordinating efforts of the TWGs to ensure the Study Board had all the information needed to formulate and evaluate the technical options for improving the ability of the United States and Canada to achieve water entitlements. Specifically, the OFEG:

- synthesized and managed the work and outputs of the TWGs, ensuring timely and relevant inter-TWG communication
- acted as a liaison between the TWGs and the Study Board
- communicated the technical work of the study to the Public Advisory Group, Indigenous Advisory Group, Government Forum and Communications Committee
- provided data management oversight by developing a Data Management Policy and working with all TWGs to ensure their data and data management needs were met
- provided regular updates on the TWGs as the technical work progressed, ensuring the Study Board was aware of all major issues that may have impacted overall study progress

- developed a visualization tool, with input from all of the TWGs on the development of the study's performance indicators, that aids in analyzing the impacts of the various modelled scenarios and options. This tool provided the Study Board with key information, allowing them to achieve consensus decisions and make recommendations.

2.5.2 Climate & Hydrology (CH) TWG

The Climate and Hydrology Technical Working Group (CHTWG) supported the Study by developing the scientific foundation needed to assess and improve access to entitled waters between Canada and the United States. Its work focused on understanding the past, present, and future climate and hydrological conditions of the watershed and providing critical inputs to other TWGs involved in the study.

The purpose of the CHTWG was to characterize hydrologic conditions under historical, current, and projected future climates. This included conducting a comprehensive assessment of observed climate and streamflow data, identifying trends and drought characteristics, and selecting representative climate projections for future analysis. Downscaled climate data from the latest Global Climate Models (Coupled Model Intercomparison Project Phase 6, CMIP6) were used to describe expected changes in temperature, precipitation, and other key variables relevant to hydrologic processes in the watershed. The CHTWG analyzed current and future climate scenarios to understand how water flows are impacted by varying timing and magnitude of runoff, precipitation, and changing snowpack.

The group was also responsible for selecting, developing, and applying hydrological models that simulate natural streamflows. These models were configured and calibrated using historical data, and then were used to generate both historical and future streamflow scenarios. Results included analyses of flow variability, shifts in seasonal patterns, changes in drought duration and frequency, and other hydrologic indicators relevant to water management and allocation.

Through its modelling efforts, the CHTWG provided essential outputs to support integrated assessments by other TWGs, particularly those focused on water management, socioeconomic impacts, and ecological responses. The ultimate outcome of the CHTWG's work supports improved, climate-resilient water apportionment between Canada and the United States, while ensuring that Indigenous perspectives, ecological flow needs, and socioeconomic considerations are fully integrated into future planning and decision-making.

2.5.3 Infrastructure Options (IO) TWG

The Infrastructure Options TWG (IOTWG) evaluated potential water infrastructure options for storage and/or conveyance that could be modified within or added to the Basin to allow for improved access to entitlements of the St. Mary and Milk Rivers.. To do this, the TWG evaluated numerous historical studies for water infrastructure development in the basin.

The Study specifically identified four infrastructure options for highest priority consideration:

1. St. Mary Canal improvement
2. Lower and Upper St. Mary Lake storage
3. Canadian Milk River storage
4. Canadian conveyance alternative.

The IOTWG also developed potential new options, making recommendations on the ones that should be modelled as part of this study. ed access to entitlements of the St. Mary-Milk Rivers. The group described and defined details of the options for incorporation into the water management models. The various structural options considered are described in Section 4.2 of this report.

2.5.4 Water Apportionment & Administrative Options (WAAO) TWG

The Water Apportionment and Administrative Options TWG (WAAOTWG) reviewed existing administrative procedures for water apportionment in the basin and explored potential changes to these procedures that may improve access to entitlements for each country. The group evaluated previous work in the basin related to options that change the way water apportionment procedures are performed, while still respecting the IJC Order of 1921. This TWG produced recommendations to the Study Board on potentially promising changes to the existing apportionment and administrative procedures used by the AOs. The proposed options aimed to increase the flexibility of apportionment methods to account for potential changes in the timing and magnitude of water availability. Many options developed by the WAAO TWG were modelled in current climate scenarios to evaluate their potential to improve access to the water entitlements of each country. The most promising scenarios for current climate conditions were modelled in one potential future climate scenario. The administrative/non-structural options are described in Section 4.3.

2.5.5 Water Management Modelling (WMM) TWG

The Water Management Modelling TWG (WMMTWG) used two water management models: the St. Mary River-Milk River Water Resources Management Model (WRMM) and St. Mary River-Milk River RiverWare model. These types of model are integrated river-basin and reservoir operations modelling system used to simulate, optimize, and evaluate water allocation, storage and river management decisions across complex water resource networks. WRMM was previously applied as part of the Alberta-Montana Initiative Taskforce and is owned and licensed by the Province of Alberta. All changes or additions to WRMM were done under the supervision and agreement of the Alberta Government. RiverWare is a modelling platform licensed by Center for Advanced Decision Support for Water and Environmental Systems (CADSWES) at the University of Colorado at Boulder. Hydros Consulting was contracted by the study to modify and create rules to model scenarios to be evaluated by the RiverWare model. Each model incorporates operational rules for distributing the water in the basin using streamflow data, water rights data, water demand data, infrastructure characteristics, and the terms of the Boundary Waters Treaty, the 1921 Order, where applicable, and current administrative procedures.

1 The Study Board considered other potential water management modelling software and was unable to
2 identify an appropriate open-source and cost-effective alternative.

3 WRMM was developed for water planning in Alberta, and compared to the RiverWare model, WRMM
4 has more water rights and water use detail in the Canadian part of the basin. The RiverWare model has
5 more water rights and water distribution details for the US part of the basin. Both models were used to
6 simulate the entire system for both rivers. Despite previous application of the models, Canadian and
7 American members of the WMMTWG spent significant time working with the individual modelling
8 teams, adjusting each model, WRMM and RiverWare respectively, to ensure consistency in model
9 applications, which allowed for more comparable outputs. The models were then used independently to
10 determine how potential options and scenarios developed by other TWGs would likely change the water
11 distribution and availability in the basin. By modelling each of the structural and administrative options
12 (and a few combinations of the two), the TWG was able to evaluate the likely improvements on the
13 apportionment and other performance indicators.

14 **2.5.6 Socio-Economic Analysis (SEA) TWG**

15 The Socio-Economic Analysis TWG (SEATWG) studied past economic assessments for the St. Mary-Milk
16 River system; historical analyses of water availability, apportionment and irrigation; water rights; past
17 drought impacts on water availability; and other past studies in the basin related to cultural and
18 socioeconomic interests. The members of the TWG described the historical use of water in the basin and
19 changes in practices during the last decade as a consequence of changes in the timing or availability of
20 water supplies and reported on concerns of the water users in the basin and the cultural role that
21 waters play in the basin. The TWG team members also compiled information describing the economic
22 value of water delivered to farms in the basin and the potential economic consequences were there to
23 be changes in water availability. The SEATWG, using a series of cited and other reports, summarized
24 estimates of the value of water in the various parts of the basin, both economically and socio-culturally.
25 They also analyzed how the irrigation season and number of recognized water users have changed since
26 the BWT was signed in 1909.

27 **2.5.7 Aquatic Ecosystems (AE) TWG**

28 The Aquatic Ecosystems TWG (AETWG) researched and produced a report (Supplementary Document
29 1.8) on the state of knowledge of aquatic ecology studies in the basin. Their work focused on gathering
30 and summarizing existing information on the fish and other aquatic species in the basin, providing a
31 wholistic understanding of the aquatic ecosystems in the basin from a food web perspective, including
32 algae, insects, and fish. This TWG reviewed studies in the basin from Provincial, State, Federal, and
33 Indigenous entities. Their work also identified threatened, endangered, and aquatic species of
34 conservation concern in the basin. These efforts provided foundational information describing the
35 existing state of aquatic ecosystems in the St. Mary-Milk basin. The AETWG's work aimed at
36 understanding the potential impact of changes in water flow on certain aquatic species, communities,
37 and critical habitats. The AETWG analyzed whether mitigation measures could be implemented to
38 maintain the benefits of water allocations while preserving ecological integrity. The AETWG identified

existing data gaps and provided recommendations of additional studies needed to better quantify the relationship between differing flow regimes and Aquatic Health responses.

One performance indicator was available to assess the effects of changing streamflow regimes and water management on a key indicator species of aquatic ecosystem health, the streamflow needs of bull trout. Additional aquatic ecosystem health PIs were not developed, due to insufficient information and time constraints. Time and resources commitments necessary to fill aquatic health data gaps were beyond the scope and means of this study. For Bull Trout (primarily in the US portion of the St. Mary River), previous work had been completed such that relationships between bull trout population health and varying flow regimes could be estimated and a PI utilized. The constraints felt by the AETWG are described in more detail in Supplementary Document 1.8; their recommended next steps included: 1) collecting short-term surveillance monitoring data to address information gaps, 2) assessing current knowledge of status and trends of aquatic ecosystems and 3) identify critical habitat and environmental flow needs for species management. Information would be used to develop additional aquatic health performance indicators.

2.6 Modelling Process

Due to the complexity of water apportionment, use, and availability, the study team worked with several models to simulate how infrastructure and administrative changes and a changing climate may affect water availability. This section summarizes the modelling process that was used by the Study.

2.6.1 Modelling the Administrative and Structural Options using Historical Information

The core of the modelling infrastructure was the two water management models used to examine the expected impacts of the administrative and infrastructure scenarios being considered by the Study Board. In many cases, elements of the modelling workflow already existed and the TWGs simply needed to evaluate the suitability of existing products. In other cases, significant work was required to complete certain components of the modelling workflow. Most of the modelling that was done in the study to support the Board's recommendations is illustrated in Figure 10, with key processes noted and described below:

1. Historic naturalized flows throughout the watersheds were obtained from a previous study (Montana DNRC, 2023). Naturalized flows are estimates of the natural (unmanaged) flows, calculated from the historical data set.
2. These historic calculated naturalized flows were input into two water management models, which also included estimates of water demands coming from irrigation use, non-irrigation use, and open water evaporation.
3. The models were run for historic "baseline" conditions using the current apportionment administrative procedures (minus the LOI), and the existing infrastructure and level of irrigation development. The results for the two models were compared, and adjustments were made to synchronize the two models.

4. The TWG-developed administrative and infrastructure options were combined into scenarios that were simulated using the water management models for the historical period.
5. These scenarios were then fed into performance indicator scripts and a visualization tool to support the study board's decision-making process.

Historic Natural Flows Modelling

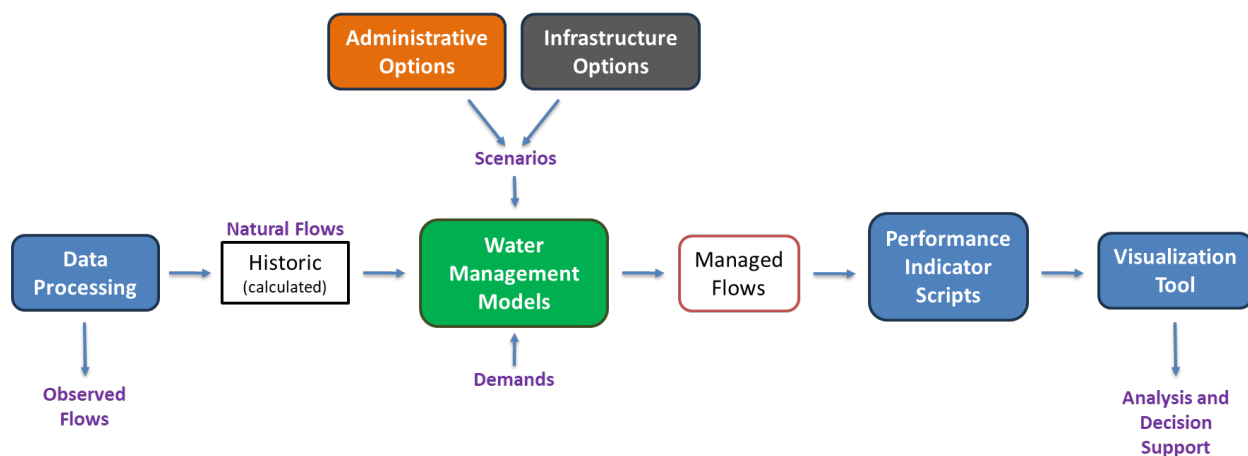


Figure 10. Overview of flow modelling process

Naturalized Flow Datasets

Throughout most of the St. Mary River and Milk River Basin today, streamflow is heavily affected and managed by diversions, consumptive uses, and reservoir operations. Naturalized streamflow refers to estimating flows as if humans had not impacted the movement of water, such as through diversions and reservoir operations. Naturalized flow is important because it provides an estimate of how rivers would have flowed without human influences such as diversions, consumptive uses, and reservoir operations. These data establish a consistent baseline for water management studies, helping distinguish the effects of natural hydrologic variability from those of human activities. Naturalized streamflow was one of the most important input datasets for the water management models. The naturalized streamflow data sets were calculated for key locations on the rivers and tributaries, based on historic gaging station streamflow data, with consumptive uses, irrigation diversions, and depletions and reservoir operations removed. The Study used existing naturalized flows data developed by the Montana Department of Natural Resources and Conservation (2023) for key locations in the rivers and tributaries for the period from 1981-2015.

Water Management Models

Water management models typically simulate the managed streamflow for a watershed, including diversion and reservoir operations, and generally require naturalized streamflow as input data. Water management models were available for this study that simulate river flow, water use (primarily irrigation), and reservoir operations for the St. Mary River, Milk River, and Eastern tributaries of the Milk River in the United States and Canada. The models also can track water apportionment and simulate the management and use of this water by entities and water users in Canada and the United States.

Several planning and operational models of the St. Mary and Milk River systems have been developed over the years, both in Canada and in the United States. The WMM TWG focused on the two current water management planning models that are most commonly used on each side of the International Boundary: the Alberta Environment and Protected Areas (AEPA) Water Resources Management Model (WRMM), and the US Bureau of Reclamation/Montana DNRC RiverWare model.

WRMM is a computer model owned by the Province of Alberta, that optimizes river flows, water storage and distribution, and water use for the St. Mary and Milk Rivers. WRMM models the St. Mary River from its headwaters to its crossing at the Canada-US border and the Milk River from its headwaters to Fresno Reservoir. It is a water accounting model that operates on a weekly timestep. The US Bureau of Reclamation and State of Montana have developed a daily timestep RiverWare model of the St. Mary River and Milk River system. RiverWare models the St. Mary River from its headwaters to its crossing at the Canada-US border and the Milk River from its headwaters to its confluence with the Missouri River.

Both the WRMM and RiverWare models simulate and track irrigation water use, the primary water use in the basins. This includes the diversion of water, use by crops through evapotranspiration, and any return flow. There are evaporative water losses due to storage in reservoirs and diversions that are also simulated and accounted for. The models can also compare irrigation demands to deliveries and track water shortages.

Water Management Model Scenarios

The water management models were employed to simulate how natural flow is apportioned based on the Boundary Waters Treaty and the IJC 1921 Order, and current Administrative Procedures except for the deficit trading as described in the letters of intent. Shares of the natural flow of the St. Mary River at the International Boundary and Milk River at the Eastern Crossing of the International Boundary were computed and summarized for each country using the water management models. The models were also used to evaluate entitlement receipts under different infrastructure and administrative options. It should be noted entitlement receipts are not necessarily equal to the water used by each country. A country might be apportioned a share of water, but due to infrastructure and other limitations, might not always be able to receive/use the full share. Further, the models simulated how different scenarios, for example, a larger capacity St. Mary Canal or a new reservoir on the Milk River, could affect a country's ability to divert or capture entitled water.

The models computed and tracked managed streamflow at locations throughout the Milk River and St. Mary River systems. Managed stream flows refer to estimated flows under different scenarios of structural and administrative options. The models also simulated and tracked the operations of the many reservoirs in the system. The output provided by the models was used to evaluate scenarios involving changes to infrastructure or administrative rules. Stipulations, such as required minimum flows at an International Boundary, also could be incorporated into the models. The scenarios are described in more detail in section 4.

Performance Indicators, Visualization Tool, and Decision Making

Performance indicators (PIs) help visualize the modelling outputs and the effect that each option and scenario may have on aspects (for example, water availability) that are important to the different interests in the basin. The PIs were identified through engagement with the PAG, IAG and GF members to ensure they are representative of the concerns of the different parties. The PIs attempted to compare the effects of different options and scenarios on multiple aspects of the basin, including receipt of entitlements, water availability for irrigation, and impacts on significant aquatic ecosystems. Examination of PIs can highlight the trade-offs to be considered when evaluating one option or scenario over another. As an example of a potential trade-off, a scenario that improves fall fish spawning might decrease the availability of water for irrigation. The Study implemented the use of PIs, which simplify all of the outputs for a model run into an impact (positive or negative) on each area of interest, thus enabling a relative comparison of each model run on each area of interest in the basin. The PIs are, effectively, relative measures of how human and aquatic interests are affected by each scenario – positive, negative, or neutral. A summary of each PI and its evaluation can be found in section 4.5.

A Data Visualization Tool was developed to interpret the extensive water management model outputs and their impact on different interests in the basin. The visualization tool takes the modelled streamflow and performance indicator data and displays them in a manner that is easier to comprehend compared to tables of output data from the models. This improved the ability to identify the key takeaways from the modelling effort and aided the overall understanding of the expected consequences of the proposed structural and non-structural changes. The performance indicators and visualization tool are described in more detail in Section 4.

2.6.2 Modelling of Potential Future Hydroclimate Conditions

Hydrologic modelling was completed to understand the potential impacts of the future climate on the performance of the scenarios that were most promising. Hydrological model performance was evaluated for the historic period. Figure 11 illustrates this process, with key elements noted and described below:

1. Hydrologic models were run using pre-processed weather data and calibrated to the historic naturalized flows.
2. Streamflow was simulated with three calibrated hydrological models using future climate data from a Global Climate Model (GCM; Lavoie and others 2024).

3. One modelled historic and future run from the HYPE hydrological model was selected to produce possible managed flows with RiverWare to assess future conditions.

Potential Future Climate Modelling Framework

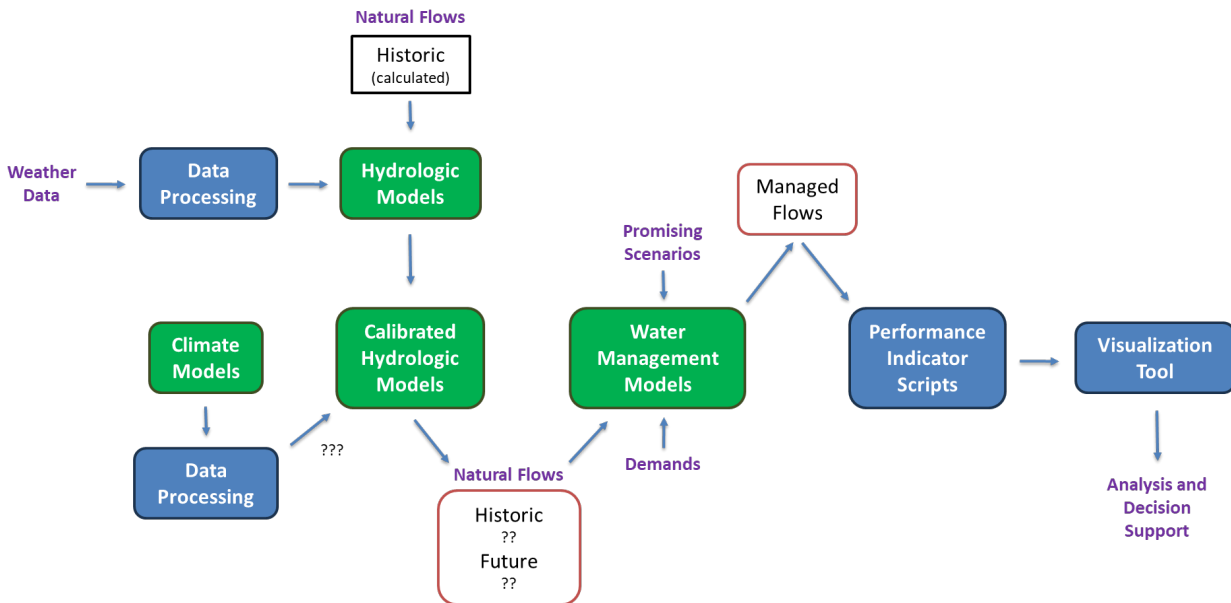


Figure 11. Process for modelling potential future climate impacts

Hydrologic Models

Hydrologic models describe how water moves through the basin. These models simulate processes such as water runoff and streamflow and can be used to predict potential future hydrologic conditions. These models require input data, including precipitation and temperature. Input data for this Study was obtained from weather reanalysis and climate prediction products. The four hydrologic models evaluated for the study were HYPE (Lindström et al. 2010), PRMS (Markstrom et al. 2015), Raven (Craig et al. 2020), and MESH (Pietroniro et al. 2007, Wheeler et al. 2022). These models were used to generate modelled historic flows and potential future modelled flows. Multiple models were used to capture the uncertainty associated with hydrologic model structure and process representation, as each model simulates watershed processes differently. Comparing results across models provides a more robust assessment of historical and future streamflow conditions. These flows were then further analyzed and one potential future natural flow dataset was used as input data for the RiverWare water management model to evaluate promising scenarios. More detailed descriptions of the individual models used in this study are included in the Water Management Modelling Technical Working Group State of Knowledge Report (Supplementary Document 1.6).

Climate Model Scenarios

Future hydrology assessment depends on projections of future climate provided by global climate models (GCMs). Although there are some uncertainties associated with GCM simulations, GCMs have

1 been widely used in the literature as the main tool available to assess future responses of hydrological
2 processes to different climate forcings (Farjad et al., 2016; Shrestha et al., 2017; Hoan et al., 2020; Chen
3 et al., 2022). One of the main limitations of GCMs is that the spatial (space) and temporal (time)
4 resolutions of GCMs are often too coarse to be used for climate impact assessment at local or regional
5 scales. To tackle this limitation, various statistical and dynamical downscaling techniques have been
6 developed to bridge the gap between the spatial and temporal resolution of climate and hydrological
7 modelling systems. Results from downscaled and bias-corrected models were ultimately used by the
8 CHTWG to develop the future scenarios of potential hydrological change. Climate models were neither
9 developed nor downscaled and bias corrected by the Study. Rather, scientifically robust global climate
10 data developed by the Coupled Model Intercomparison Project Phase 6 (CMIP6 - Eyring et al. 2016) that
11 were subsequently downscaled and available (Lavoie, J., et al., 2024) for the cross-border assessment
12 were selected for use in the Study. (Eyring et al. 2016). Existing processed output data from the climate
13 models was input into the hydrologic models. Data processing refers to aligning weather and climate
14 model output to hydrologic models used in the Study.

15 *Potential Future Climate Water Management Simulation*

16 Ideally, many different hydro-climate simulations would be run through the water management models
17 characterize the uncertainty associated with potential future stream flows in the region. This was done
18 with the hydrological models. Due to resource constraints, only one simulation of naturalized flows from
19 the hydrological models was used as an input to the water management model RiverWare. The scenario
20 was selected from a series of 15 HYPE Model future scenarios and represented an average future
21 condition as predicted by the HYPE modelling system. This was deemed sufficient since the purpose of
22 the work was to assess system robustness. The one simulation that was selected best represented a
23 moderate future climate scenario from 2015 to 2100. The visualization tool shows hydrologic output for
24 the historic, mid-century, and late-century periods for comparison with the calculated historic flows.

3 ENGAGEMENT AND OUTREACH IN THE STUDY

Throughout the study, the perspectives of the public, stakeholders, Indigenous Nations and basin communities, and appropriate government agencies were actively engaged by gathering socioeconomic and hydrological information and fostering dialogue in both Canada and the United States. The IJC is committed to providing all interested parties with opportunities to be engaged and heard, including emphasizing the importance of public outreach and participation. Input from farmers, ranchers, municipal users, Indigenous groups, and others was notable, with calls from the groups for transparent, adaptive water management. Participants stressed the need for infrastructure upgrades and long-term sustainability across agriculture and ecosystems. They cited climate change and drought impacts, noting that not all stakeholders will benefit equally from new strategies. There was strong support for cross-border cooperation, inclusive governance, and practical, science-informed decisions with clear trade-offs.

3.1 Public Engagement and Outreach

The Study Board used several methods and approaches for participation, engagement, and outreach, including through the PAG, public meetings, focused Indigenous engagement with the IAG, and the Study Board web page. The principal objectives for public and Indigenous engagement were to:

- Strive to ensure that the study process is open, inclusive and fair;
- Make the public aware of the study, its purpose, and process, including how decisions will be made;
- Provide opportunities to all interested parties to participate;
- Enhance public understanding of how water is apportioned in the Basin;
- Inform the study by identifying and building on local expertise, knowledge and information;
- Invite and consider the views of all interests of the principal issues;
- Identify and consider the public's, rights holders' and diverse stakeholders' priorities and preferences in the plan formulation;
- Broadly disseminate study findings as they become available; and
- Encourage the public, rights holders, and stakeholders to share study findings with others.

"The public" refers to any person, association, organization or group that is affected by, likely to be affected by, or has an interest in the study and any decisions that may ultimately be taken by the IJC in response to the findings or recommendations of the study. The term "stakeholders" refers to those with direct interest in water management within the Basin, and includes decision-makers, public opinion influencers and elected officials. The term "rights holders" represents those with current or ancestral

interests in water management and is broadly defined as Indigenous Nations, including First Nations, Métis Nation and Tribes.

3.2 Public Meetings and Outreach Opportunities

During public meetings, the Study Board Co-Chairs invited comments from the public on specific and general issues associated with the study and provided opportunities for members of the public to express their views regarding the study.

Public engagement meetings, events and activities included:

- October 2022: In-person Town Hall in Milk River, Alberta
- October 2022: In-person Town Hall in Shelby, Montana
- May 2023: PAG Meeting and Town Hall in Havre, Montana
- June 2023: Newsletter Issue 1 release
- October/November 2023: In-person PAG, IAG, Government Forum, and Study Board meetings and engagement in Great Falls, Montana
- December 2023: Newsletter Issue 2 release
- December 2023: Performance Indicator factsheet release
- January 2024: PAG Meeting Virtual Meeting
- March 2024: Preliminary modelling results public webinar
- June 2024: In-person Public Meetings and PAG Town Hall in Lethbridge, Alberta
- July 2024: Newsletter Issue 3 release
- October 2024: In-person Town Hall in Malta, Montana
- November 2024: In-person Study Board and Advisory Group meetings and public engagement in Montana
- December 2024: Newsletter Issue 4 release
- January 2025: Virtual PAG, IAG and Government Forum Webinar
- April 2025: PAG, IAG Seminar Series (Virtual)
- May 2025: Virtual PAG, IAG and Government Forum Webinar
- June 2025: Newsletter Issue 5 release
- September 2025: Virtual PAG, IAG and Government Forum Webinar
- February 2026: Newsletter Issue 6 release

- August 2026: in-person Public Meetings in Havre, Montana; Milk River, Alberta; and Lethbridge, Alberta

3.3 Public Advisory Group (PAG)

The Public Advisory Group (PAG) was comprised of individuals who have diverse interests in the basin and represent various geographic locations across the basin. The PAG included an equal number of people from Canada and the United States. A list of PAG members is provided in the Supplementary Document: Study Participants.

PAG members were asked to draw upon their knowledge, contacts and experience to provide informed input to the study and to develop effective techniques to engage the public and stakeholders. The PAG performed the following duties:

- Advised the Study Board on public involvement and information exchange;
- Served as a conduit for public input to the study process, and for public dissemination of study outcomes;
- Reviewed and provided feedback on Study Board approaches, reports, products, findings, and conclusions as requested; and
- Advised the Study Board on the responsiveness of the study process to public concerns.

As part of the study, there were focused engagement sessions with the PAG to gain insights on the basin and water management. This engagement brought together a diverse group—including farmers, ranchers, municipal users, and Indigenous communities—to share perspectives on water management in the St. Mary and Milk River basins. It combined socio-cultural research and scenario-based discussions to better understand community priorities, concerns, and trade-offs. Participants explored management options, infrastructure needs, and climate challenges while interacting with modelling tools to visualize impacts. The process fostered greater collaboration, transparency, and cross-border thinking. Overall, it provided a platform for informed dialogue focused on sustainable and adaptive water governance.

Throughout the project, PAG members consistently emphasized the Milk and St. Mary rivers as vital resources for their communities and ecosystems. Their appreciation for shared interests among farmers, ranchers, municipal users and Indigenous communities was evident from the outset. However, the socio-cultural research team observed an increased willingness to collaborate over the project's duration. Many advocated for more adaptive, transparent and locally responsive water management practices. Others highlighted the necessity of infrastructure investments, particularly to repair or replace critical diversion and conveyance structures on both rivers. A recurring theme was the paramount importance of long-term sustainability for agriculture, ecosystems and cross-border relationships. Participants articulated the significance of adaptive water-sharing agreements, robust infrastructure, Indigenous inclusion, transparent governance and sustained investment in watershed health.

The PAG recognized prolonged drought and climate shifts as threats to the socioeconomics of their communities. The notion that all users would benefit from new management strategies was rejected. They also expressed awareness that even if a strategy was the appropriate course of action, some users would be negatively impacted. Only when storage was discussed did the participants perceive opportunities for greater advantages throughout the Basin. A desire for cross-border cooperation emerged from the interviews, with many participants urging decision-makers to consider the watersheds as an interconnected system rather than a set of separate national interests. Participants supported infrastructure investments and water storage options that enhance overall system functionality, regardless of their location relative to the border. They emphasized that solutions should be developed collaboratively and deliver shared benefits and full entitlement of water.

PAG participants were not resistant to science or planning; they simply wanted to understand the criteria and tools shaping decisions that directly affect their water access and livelihoods. There was skepticism about the data inputs and assumptions used in modelling efforts. However, participants appreciated the interactive data visualization tool displaying outputs of different management scenarios, which allowed them to compare benefits. For many, the tool engenders confidence because participants can see their variables of interest and quantifications of who would be affected by each management scenario and in what ways. They understand the trade-offs involved in water management and bring pragmatic, often innovative, ideas to the table based on decades of work in farming, irrigation and local governance.

3.4 Indigenous Engagement

The Directive compelled the Study Board to fully involve Indigenous Peoples in the Study. The engagement of Indigenous Peoples has provided historical and cultural perspectives around water into the Study where possible and applicable. In addition, the Study Board has learned and listened to Indigenous members from the St. Mary and Milk River basin about their work in researching and sustaining ecosystems (e.g. fisheries, wetlands) in the face of changing climates and land use (e.g. drought, fire). Indigenous water rights in both the United States and Canada were not directly considered in the Study, as these are domestic matters. However, in developing its recommendations, the Study Board incorporated Indigenous interests through the creation of relevant performance indicators. Furthermore, the water management models used in the Study accounted for Tribal water rights in allocating the US apportionment.

Indigenous perspectives were sought through outreach and engagement with the objective of honoring and respecting Indigenous perspectives and cultural values and connections to the waters of these watersheds. The opportunities to engage Indigenous perspectives provided by the Study cultivated a knowledge exchange between Indigenous members of the basin and the IJC and the Study Board believes these connections will continue beyond the end of the Study timeline.

There are 14 Indigenous Nations that have historic and cultural ties to the St. Mary and Milk Rivers basin (Figure 12). Within the Canadian portion of the St. Mary and Milk Rivers basin, there are 8 Indigenous Nations residing or having land in the watershed, including the Kainai Nation (Blood Tribe), Métis Nation

of Alberta (District 1 and District 2), Métis Nation of Saskatchewan (Western Region 3), Cega'Kin Nation (Carry the Kettle Nakoda Nation), Little Pine First Nation, Nekaneet First Nation, and Sturgeon Lake First Nation. Within the US portion of the St. Mary and Milk Rivers basin, there are 6 Indigenous Nations residing or having land in the watershed, including Amskapi Piikani (Blackfeet Nation), Little Shell Tribe of Chippewa Indians of Montana, Chippewa Cree Tribe of Rocky Boy Montana, Fort Belknap Indian Community, Fort Peck Tribes, and Turtle Mountain Chippewa (reservation lands in North Dakota).



Figure 12. Indigenous Nations residing in or having lands and interests in the St. Mary and Milk Rivers Basin

To ensure that indigenous perspectives, voice and knowledge were reflected in the study, the Study Board established an Indigenous Advisory Group (Section 3.5). In addition, a contact list of Indigenous members from basin communities was compiled, and information, communication products and invitations to public meetings regarding the study were regularly shared with this group. Members of the Indigenous Nations were also involved in the TWGs and advisory groups, as summarized in Table 5.

1 **Table 5. Indigenous Participation in ISMMRS Groups**

ISMMRS Group	Indigenous Nation
Government Forum	Fort Belknap Indian Community Amskapi Piikani (Blackfeet Nation) Kainai Nation
Aquatic Ecosystems Technical Working Group	Amskapi Piikani (Blackfeet Nation) (Fisheries Biologist) Fort Belknap Indian Community (Environmental Scientist from Tribal College faculty of Aaniiih Nakoda College)
Socio-Economic Analysis Technical Working Group	Amskapi Piikani (Blackfeet Nation) (Climate Change Coordinator)
Climate and Hydrology Technical Working Group	Amskapi Piikani (Blackfeet Nation) (Hydrologist) Fort Belknap Indian Community (Hydrologist from Tribal College faculty of Aaniiih Nakoda College)

2 The Study Board recognized the importance of including Tribal Colleges & Universities (TCUs) in its
3 engagement activities. Many of the TCUs in the United States are engaged in research related to natural
4 resources. One of the most successful connections by the Study was with Aaniiih Nakoda College (ANC),
5 which serves the Fort Belknap Indian Community (FBIC), offering post-secondary education to members
6 of the Aaniiih and Nakoda Tribes. ANC has a research-focused Water Science Center funded by the
7 National Science Foundation that holds annual community water forums, provides training in hydrology-
8 related sciences for Indigenous students, and promotes discussions around water for the community.
9 The Study participated in three of the ANC sponsored annual FBIC Water Forums and held a community
10 meeting for FBIC supported and promoted by the ANC Water Science Center. The connection with ANC
11 and the Water Science Center increased the reach of the Study to Indigenous members from FBIC and
12 added diverse Indigenous perspectives, meeting Study objectives and suggesting an important avenue
13 for Indigenous engagement in future IJC studies.

14 Study staff liaised and communicated with all Indigenous Nations in the watershed to ensure they were
15 aware of opportunities to get involved and received updates on study work if desired.

16 The Study Board was also dedicated to learning about the work of Indigenous Nations in the basin and
17 invited Indigenous Nations and organizations to present at Study Board meetings. The Study Board
18 received presentations from the Blood Tribe Land Management Department on November 15, 2024,
19 and the Blackfoot Confederacy Tribal Council on January 10, 2025, to learn about ongoing work in the
20 basin inclusive of environmental and water management.

21 **3.5 Indigenous Advisory Group (IAG)**

22 To ensure that Indigenous perspectives, voices and knowledge were reflected in the work of the study,
23 the Study Board established an Indigenous Advisory Group (IAG) to offer members of Indigenous
24 Nations (First Nations, Metis Nation and Tribes) an opportunity to inform the study of Indigenous
25 interests, Indigenous Knowledge, and Indigenous Science.

Indigenous engagement at large and invitation to participate on the IAG commenced in June 2022, when the Board invited more than 30 contacts from all 14 Indigenous Nations to virtual information session; this meeting was attended by 18 representatives from nine Indigenous Nations in the basin. The Study Board subsequently followed up with interested Nations and invited them to join the IAG. Ultimately, the IAG consisted of three members from Indigenous Nations within Canada, and four members from Tribes within the United States:

- Fort Belknap Indian Community
- Amskapi Piikani (Blackfeet Nation)
- Little Shell Tribe of Chippewa Indians of Montana
- Fort Peck Tribes
- 'At – large' IAG member (Cowessess First Nation)
- Métis Nation Alberta
- Nekaneet First Nation

Other members of Indigenous Nations with an interest in the study, but potentially limited capacity or time to dedicate to the study, were invited to participate as observers to the IAG. Members of Indigenous Nations within Canada who attended meetings as observers including members of the Kainai Nation and Blackfoot Confederacy Tribal Council. Members of Indigenous Nations within the US who attended meetings as observers include Bureau of Indian Affairs, members of Amskapi Piikani (Blackfeet Nation), and Fort Belknap Indian Community.

Once established, the IAG worked together primarily through virtual means, with in-person meetings hosted in Great Falls, Montana and Lethbridge, Alberta. In addition to meetings with the Study Board and the OFEG Leads, the IAG interacted with the Public Advisory Group (PAG), and was invited to attend public meetings hosted throughout the basin as well as virtually. Beginning in April 2025, the IAG was invited to attend a Seminar series hosted by the Study Board on topics that included the history of the Boundary Waters Treaty and apportionment within the basin, a revision of the structural and non-structural options under consideration by the study, and a discussion of study progress at large. While a portion of each seminar included presentations from Study Board members, the Study Board also used this time to answer any questions that IAG members had and receive feedback on its work.

A summary of IAG meetings:

- September 2022: First IAG virtual information meeting
- February 2023: Virtual informational meeting focusing on an overview of the study and polling questions to invite comments and input on connection to the rivers and interest in participating in the study

- 1 • March 2023: Virtual meeting with Study Board that offered the chance for Study Board
2 members and advisory group members to spend time learning about each other
- 3 • July 2023: Virtual meeting focusing on an in-depth introduction to the TWGs and the role of
4 performance indicators in the Study
- 5 • September 2023: Hybrid meeting hosted by Aaniiih Nakoda College at Fort Belknap Indian
6 Community to discuss and provide input on the work of the TWGs
- 7 • November 2023: In-person meetings and engagement in Great Falls, Montana to learn about
8 perspectives in the basin, discuss study updates and provide input into the technical work,
9 including development of PIs and scenarios
- 10 • March 2024: Public meeting to update the IAG and PAG membership on TWG progress and
11 planned outcomes including how performance metrics will be included in the work of the TWGs
- 12 • April/May 2024: Virtual meeting
- 13 • June 2024: In-person PAG, IAG, Government Forum, and Study Board meetings and engagement
14 in Lethbridge, Alberta. While no formal IAG members were available to attend, there was
15 participation from FBIC, BIA, and Government Forum members from Amskapi Piikani (Blackfeet
16 Nation), Fort Belknap Indian Community and Kainai Nation. The Lethbridge meetings included a
17 visit to the Blood Tribe lands to learn about the Blood Tribe Agricultural Project (BTAP)
- 18 • June 2024: In-person engagement with Kainai Nation
- 19 • August 2024: Virtual meeting to discuss happenings in the basin, including the siphon failure on
20 the St. Mary Canal, as well as technical work and updates from the Lethbridge meetings
- 21 • November 2024: In-person Study Board and Advisory Group meetings and public engagement in
22 Montana. The Study Board received a presentation from the Blood Tribe Land Management
23 Department on work they are doing in the basin
- 24 • January 2025: Virtual presentation by Blackfoot Confederacy Tribal Council on work being done
25 in the basin
- 26 • January 2025: Virtual PAG, IAG and Government Forum Webinar
- 27 • April 2025: PAG, IAG Seminar Series, including Boundary Waters Treaty and Natural Flow,
28 Review of Structural Options, and Review of Non-Structural Options
- 29 • May 2025: Virtual PAG, IAG and Government Forum Webinar on study progress, highlights, and
30 decision-making process
- 31 • August 2025: Virtual Study Board demonstration of the model visualization tool
- 32 • September 2025: In-person meetings (with virtual option) in Lethbridge, Alberta focused largely
33 on administrative and infrastructure options being considered, providing opportunity for
34 feedback from advisory group members

- January 2026: Virtual IAG, PAG and Government forum meeting to demonstrate visualization tool results and provide updates
- March 2026: Virtual meeting with IAG and PAG for advisory group members to provide feedback on the Study Board's provisional recommendations

Input from the Indigenous Advisory Group was mostly focused on issues that were beyond the narrow mandate of the Accredited Officers, related to effects of water apportionment on fish and wildlife health and riparian areas. IAG participants underscored the critical importance of safeguarding water flows to sustain fisheries, ecosystems and traditional land uses. Concerns were raised regarding the study's scope, including groundwater, water quality and culturally significant species and habitats. Many participants emphasized the need to respect Indigenous rights, knowledge and decision-making roles in water management and infrastructure development. There were mixed views on storage and diversion, with support contingent upon ecological protection, water security and shared benefits. The Study Board was appreciative of those comments but unable to specifically address many of those comments that were largely beyond the scope of the Study. Nonetheless, it was important for the Study Board to hear these concerns. Detailed comments were received on the Board's draft final recommendations and the Board responded in writing to those comments from individual IAG members. These comments influenced the development of performance indicators, particularly with regard to aquatic ecosystem health, and provided valuable perspective to the Study Board as it considered its recommendations and the path forward.

3.6 Government Forum

The Government Forum (Forum) provided feedback to the Study Board from the Indigenous, State, Provincial, and Federal governments. The Forum members included managers from agencies with water resource responsibilities directly related to the Study. Members of the Forum were formally appointed by the IJC, as were two Special Liaisons between the Government Forum, Study Board, and IJC. Several of the agencies represented in the Government Forum contributed staff to the TWGs and provided important technical information and support to the Study Board concerning policy and operations of the St. Mary and Milk River systems.

Members of the Government Forum from jurisdictions within Canada:

- Government of Alberta Ministry of Environment and Protected Areas
- Environment and Climate Change Canada
- Saskatchewan Water Security Agency
- Kainai Nation (Blood Tribe)

Members of the Government Forum from jurisdictions within the United States:

- Fort Belknap Indian Community
- Montana Department of Natural Resources and Conservation
- US Bureau of Reclamation
- Amskapi Piikani (Blackfeet Nation)

The timing and manner of input received from Government Forum members was varied, but represented additional important feedback that influenced the Board's approaches on issues such as identifying which infrastructure options were important to contemplate or additional considerations in potential implementation of recommendations.

3.7 Communications

The Communications Committee for the study consisted of IJC Communications staff, the two Study Managers, PAG co-chairs, and one Board member from each country. The Communications Committee was responsible for coordinating PAG, IAG, IJC and external engagement and outreach throughout the Study.

During the Study, the Communications Committee assisted the Study Board in providing information to the public through semi-annual **newsletters**. These newsletters included background information on the basin, the governance framework of the four-year study, updates on meetings and workshops, and future endeavors.

Additionally, the Study Board published and circulated **fact sheets**. These short publications focused on defining performance indicators in the context of the Study, explaining water apportionment in the basin, describing basin geography and infrastructure, and summarizing the Study Work Plan. The Study also shared fact sheets explaining the modelling process used by the TWGs to understand changes in managed stream flow under a variety of structural, non-structural, and climate scenarios. These were posted to the Study Board website and distributed to the public, relevant stakeholders, and rights holders.

4 DESCRIPTION AND EVALUATION METHODS OF STUDY OPTIONS AND SCENARIOS

In accordance with the IJC's directives, the Study Board assessed various structural and non-structural options, and a combination of these options, to enhance each country's receipt of entitled waters of the St. Mary and Milk Rivers. These options, or scenarios (henceforth used interchangeably), were developed to incorporate changes and challenges to apportionment since the issuance of the original 1921 Order.

The results of water management model runs using historical data were used to evaluate different options/scenarios. For this study, a base case scenario was selected to represent existing water management conditions in the St. Mary and Milk River basins. The base case was a simplified version of the actual operating procedures because the actual procedures are complex and involve subjective decision-making. For example, the AOs use the LOI to allow deficits from one river to offset deficits on the other river for beneficial use in both rivers; these procedures were not modelled due to the complexity of the decision-making process. The base case scenario for the Study is the St. Mary Canal with a flow of 600 ft³/s (17 m³/s) and current Apportionment Procedures (without the LOI; the LOI is rarely used at this time, so there is little effect to the model results related to the LOI not being modeled.) Each subsequent scenario was then built into the water management models to simulate the impacts of different structural and non-structural options on the availability of water for apportionment. These results using historical flows were evaluated to identify the scenarios with the most favorable potential outcomes using the performance indicators. Managed flow from model runs using climate change data was evaluated in general terms to understand how the most promising scenarios would perform under different climate conditions. Additionally, aquatic ecosystem and socioeconomic effects were evaluated by the Study. Study option/scenarios were modelled in a sequential process that allowed adjustments to modelled scenarios, including combinations of infrastructure and administrative options.

4.1 Options and Scenarios

As noted in Section 2.2, some options and scenarios were described in the Study Work Plan and developed for the Study. After modelling the scenarios in the workplan, additional scenarios were developed and defined for modelling with the Water Management Models. A summary of options/scenarios developed and refined for modelling are shown in Table 6.

- 1 **Table 6. Options/Scenarios modelled during the Study**
- 2 **Gray shading demotes scenarios that were proposed in the Study workplan.**
- 3 ***Options/Scenarios modelled with both 600 and 850 ft³/s canal capacity are noted with an asterisk.**

Option/Scenario	Description	Option/Scenario type
Base Case	Estimated current conditions using administrative procedures defined in the Treaty and the Order, without the LOI, and the canal capacity of 600 ft ³ /s (17 m ³ /s). The base case was used as a consistent scenario to which all others were compared.	None
St. Mary Canal Improvement	Rehabilitation of the US St. Mary Canal to the original capacity of 850 ft ³ /s (24.1 m ³ /s)	Structural
US Lower St. Mary Lake Storage*	Inflatable dam creates storage in the Lower St. Mary Lake by retaining the spring freshet until later in the irrigation season. Lake level will not exceed the typical high-water level naturally achieved. Storage could be refilled during the year depending on snowmelt timing. Maximum storage of 8,800 acre-feet (10,900 dam ³)	Structural
Canadian Milk River Storage (1)* (Forks Reservoir)	On-channel storage on the Milk River in Canada 3 miles downstream of confluence of Milk River and North Milk River. Maximum storage of 257,000 acre-feet (317,000 dam ³).	Structural
Canadian Milk River Storage (2)* (Miners Coulee)	Off-channel storage in a Milk River tributary Coulee at confluence of Miners Coulee and MacDonald in Canada. Maximum storage of 15,000 acre-feet (18,500 dam ³)	Structural
US Upper and Lower St. Mary Lake Storage*	Inflatable dam creates storage in both Upper and Lower St. Mary Lakes by retaining the spring freshet until later in the irrigation season. Lake levels will not exceed the typical high-water level naturally achieved. Seasonal maximum combined storage of both Lakes is 16,800 acre-feet (20,700 dam ³)	Structural
Modified Annual Balancing*	For each river, surplus and deficit deliveries are accounted for as a cumulative balance over the period from November 1 to October 31 of the following year. The United States may carry a maximum over-delivery credit of 20,000 acre-feet (24,700 dam ³) on the St. Mary River, while Canada's maximum over-delivery credit on the Milk River is 4,000 acre-feet (4,900 dam ³).	Administrative

Option/Scenario	Description	Option/Scenario type
	During the irrigation season, each country may use its accumulated credit. The United States may divert additional water from the St. Mary River up to its credited amount, and Canadian irrigators may withdraw Milk River water up to Canada's credited amount. A minimum daily instream flow on the St. Mary of 200 cfs or the Canadian Share (whichever is less) should be met.	
Capped Credit*	Upstream countries allowed to accumulate credit for surplus flows delivered between November 1 and October 31. US credit is capped at 32,000 acre-feet (39,500 dam ³) on St. Mary, and Canadian credit is capped at 16,000 acre-feet (19,700 dam ³) on the Milk River. Canadian credits on the Milk River are drawn from the natural flow of the Milk River at the Eastern Crossing, except when the natural flow is insufficient, in which case, Canada may draw upon a maximum credit of 4,000 acre-feet (4 934 dam ³) from the US St. Mary canal diversions flowing through the Milk River.	Administrative
No Cap Credit*	Upstream countries allowed to accumulate credit for surplus flows delivered between November 1 and October 31 with no cap on accumulated credits. The upstream country is not permitted to make deficit deliveries unless they have accumulated credit water. Canadian credits on the Milk River are drawn from the naturalized flow of the Milk River at the Eastern Crossing, except when the naturalized flow is insufficient, in which Canada may draw a maximum credit of 4,000 acre-feet (4 934 dam ³) from the US St. Mary canal diversions flowing through the Milk River.	Administrative
Lower St. Mary Lake Storage and Capped Credit*	See descriptions of individual scenarios above	Combination
Upper and Lower St. Mary Lake Storage and Modified Annual Balancing*	See descriptions of individual scenarios above	Combination

Option/Scenario	Description	Option/Scenario type
Upper and Lower St. Mary Lake Storage, Modified Annual Balancing, and Forks Reservoir*	See descriptions of individual scenarios above See descriptions of individual scenarios above	Combination
Miners Coulee and Capped Credit*	See descriptions of individual scenarios above	Combination
Miners Coulee and Modified Annual Balancing	See descriptions of individual scenarios above	Combination

1

2 4.2 Structural Options

3 The structural options in this Study consisted of infrastructure built to either store or convey water. The
 4 IO TWG developed structural options by evaluating historically proposed structural alternatives (e.g., by
 5 the JIT) within both Canada and the United States to create a starting point for reviewing and analyzing
 6 structural options. The IO TWG considered all structural options/scenarios recommended in the Study
 7 Work Plan and additional scenarios developed by the TWGs, OFEG, and others. Options/scenarios that
 8 were modelled are noted in Table 6 above, with detailed descriptions defining each option/scenario in
 9 section 4.2.1. Options/scenarios considered but not modelled are described in section 4.2.2.

10 4.2.1 Modelled Structural Options

11 One conveyance option and four storage options were selected for modelling (Table 6). These
 12 options/scenarios were selected after recommendations from the IO TWG, the suggestion of Advisory
 13 Group members, and approval from the Study Board. Details of the modelled infrastructure options are
 14 described below:

- 15 • St. Mary Canal rehabilitation to allow flow of 850 ft³/s: This scenario increases the capacity of
 16 the St. Mary canal to 850 ft³/s (24 m³/s).
- 17 • Increased Lower St. Mary Lake Storage: An artificial control structure is placed at the outlet of
 18 Lower St. Mary Lakes to create additional storage (Lower St. Mary Lake additional storage
 19 modelled: 8,800 acre-feet (10,859 dam³).
- 20 • Increased Lower and Upper St. Mary Lake Storage: An artificial control structure is placed at the
 21 outlet of both St. Mary Lakes to create additional storage of 16,800 acre-feet (20,731 dam³).

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- Canadian Milk River Storage: Forks Reservoir: This scenario adds a 257,000 ac-ft (317,004 dam³) storage reservoir on the Milk River, 4.5 km (2.8 mi) downstream of the North Milk River confluence. Additionally, the Forks Reservoir scenario was also run with an expanded irrigation demand on the Milk River in Canada. The expanded irrigation demand scenario was derived by increasing the irrigated area to 35,000 acres (14,164 ha), a level sufficient to align water demand with Canada's average annual entitlement from the Milk River. This scenario represents potential full utilization of the entitlement rather than the typical demand of existing Milk River irrigators. The model assumes only Canadian Milk River entitlements are stored.
- Canadian Milk River Storage: Miners Coulee Reservoir: This scenario adds a 15,000 ac-ft (18,500 dam³) storage reservoir on MacDonald Creek. Miners Coulee Reservoir is an off-channel storage option that would allow capture and storage of the runoff from the Milk River tributary along with Canadian share of Milk River water that could be pumped from the river into the reservoir.

4.2.2 Structural Options Considered but Not Modelled

Several structural options were considered for inclusion in the study but were not modelled, primarily due to the complexity of the water management rules and Study time constraints. These are summarized below.

Two recommended structural options related to additional conveyance of St. Mary water to the Milk River in Canada were not modelled. One option recommended in the Study workplan was the Canadian Conveyance Alternative, which would create an additional canal and/or pipeline in Alberta to move water from the St. Mary basin to the Milk River basin through the Milk River Ridge Reservoir. The other option, recommended by one of the PAG members, was to move water through a pipeline directly from the St. Mary River to the Milk River near Whiskey Gap. The intent was to increase the volume of St. Mary water that could be moved into the Milk River for users in either Canada or the United States. Evaluation of these options by the IO TWG described multiple complexities such as the ability to store water in currently utilized reservoirs (such as the Milk River Ridge Reservoir) in the St. Mary River basin in Canada, the amount of energy needed to pump water from the St. Mary River or reservoirs up and over Milk River Ridge, the likely denial of permits for inter-basin transfers, and the water quality impacts due to water flowing across a saline landscape. As a result, these structural options were not modelled.

A modification to the Forks Reservoir scenario designed to store water for both the United States and Canada was also considered but was not modelled. While sharing the storage could provide additional resilience and storage, the complexities of how to manage this storage (which country's water would be prioritized for storage, how would multi-year use from withdrawal or evaporation be accounted for, etc.) were more than the Study could model due to time and resources constraints.

4.3 Non-Structural Options

The Montana-Alberta JIT developed several non-structural or administrative options which the WAAO TWG used as a foundation for developing administrative options. The WAAO TWG considered these and other options and developed three recommended administrative options to model.

4.3.1 Modeled Non-structural Options

Three administrative options were modelled along with the structural options/scenarios: a no-cap credit option, a capped credit option, and a modification to annual balancing periods. The administrative options considered in this study included:

1. **Capped credits:** allows the upstream jurisdiction to receive credit for surplus flows delivered from November 1 through October 31. The annual credit cap for the United States on the St. Mary River is 32,000 acre-feet (39 471 dam³). The annual credit cap for Canada on the Milk River is 16,000 acre-feet (19 744 dam³). In both the St. Mary and the Milk, no more than this amount of credit, in total, can be used on an annual basis.

When drawing on its credits, the United States must maintain minimum flows in the St. Mary River at the International Boundary. Canadian credits on the Milk River are drawn from the naturalized flow of the Milk River at the Eastern Crossing, except when the naturalized flow is insufficient, in which case Canada may draw a maximum credit of 4,000 acre-feet (4 934 dam³) from the US St. Mary canal diversions flowing through the Milk River. Credit balances are set to zero on November 1 of each year. Any withdrawals when there is insufficient Milk River natural flow will be taken from US St. Mary diversions up to a maximum of 4,000 acre-feet (4 934 dam³).

When St. Mary naturalized flow is less than 570 ft³/s (16.1 m³/s) the maintained flow must be the lesser of either Canada's entitlement or 200 ft³/s (5.7 m³/s). When the naturalized flow of the St. Mary River is greater than 570 ft³/s (16.1 m³/s) the flow at the International Boundary must be maintained at 35 percent of the naturalized flow.

2. **No-cap credits:** scenario details are the same as they are for the capped credit, except there is no limit on how much credit an upstream country can accumulate.

3. **Modified Annual Balancing:** the balancing period is November 1 - October 31 of the following year. Deliveries of water (either surplus or deficits) are calculated daily as a running balance (i.e., the daily surplus is added or deficit is subtracted from the cumulative deliveries to date, which may be in surplus or deficit). A minimum daily instream flow on the St. Mary of 200 cfs or the Canadian Share (whichever is less) should be met.

On the St. Mary River, the United States may divert either more or less than its daily entitlement, provided that its cumulative deficit does not exceed 20,000 acre-feet (24,670 dam³). Any deficit remaining on October 31 is carried forward into the next apportionment

year and must be repaid by deducting it from subsequent US surplus flows. No additional deficit may be accumulated until the outstanding deficit from the previous year has been fully repaid.

On the Milk River, Canada may withdraw either more or less than its daily entitlement. During the irrigation season (April 1 to October 31), any withdrawals exceeding the daily entitlement are first charged against the naturalized flow of the Milk River at Eastern Crossing. However, when naturalized flows are insufficient to meet Canadian irrigation demand, Canada may use up to 4,000 acre-feet (4,934 dam³) of accumulated credit derived from US St. Mary River diversions conveyed through the Milk River. Any deficit remaining on October 31 is carried forward into the next apportionment year and must be repaid by deducting it from future Canadian surplus flows. No additional deficits may be accumulated until the outstanding deficit from the previous year has been fully repaid.

4.3.2 Non-structural Options Considered but Not Modelled

The WAAO TWG explored several administrative options that were not simulated by the water management models, primarily due to the complexity of the water management rules, limited modelling resources and Study time constraints.

Deficit trading was initially considered an option, but was not ultimately modelled due to the level of subjectivity that is required as part of the decision-making process. The SMM LOI deficit-building process is subjective because it depends on management decisions, assumptions about natural flows, operational constraints, forecasts, accounting procedures, and baseline conditions. Despite following established rules, different interpretations of hydrologic conditions or operational priorities can lead to varying estimates of the deficit's magnitude and timing. Currently, the deficit trading that is in place as part of the LOI requires that the downstream country incurs a deficit early in the season to withdraw more than their entitlement later in the season. In recent years, a deficit has not been built, leading to no additional water availability for the upstream country. Credit-trading options allow for credits to be accumulated for the upstream country and as such were prioritized because of their reliability and known expectations for implementation.

One credit option that was designed but not fully modelled was the split-cap credit option that established a capped, seasonal credit system that allowed the United States and Canada to accumulate and redeem limited water credits based on surplus deliveries, with credits adjusted according to hydrologic conditions, subject to minimum and maximum caps, and cancelled if not used by specified deadlines. The complexity of rules for this model made coding this option exceedingly complex and time consuming. Study resources and priority requirements precluded this level of analysis. Because the no-cap and capped options would provide bookends for evaluating credit options, it was decided that split-cap credit options would not be considered.

The study work plan noted a re-visit of the 1921 Order in consideration of a changing climate, changing prior appropriation amounts, revising shares of water at different flows, and re-evaluating the definition of the irrigation season due to climate change. The 1921 Order was not revisited.

It is worth noting that all of the administrative options allowed Milk River irrigators in Canada to access up to 4,000 acre-feet (4 934 dam³) of US St. Mary Water conveyed through the canal to balance a deficit or credit if there was no natural flow in the Milk River. No administrative options were modelled where Canada would not have access to this water in dry years and a credit or deficit was available. Future work may want to consider modelling these scenarios.

4.4 Adjustments to Modelled Options

Modelling results are discussed in Section 5; however, a modification to model inputs was developed based on evaluation of the results and as the study proceeded. As discussed below, it was determined that the water management models were both limiting Canadian Milk River withdrawals, and hence water received by Canada in the Milk River, based on current Canadian Milk River irrigation demand. To evaluate the effects of storage infrastructure, the models needed to adjust irrigation demand to determine what type of access to Canadian Milk River entitlement might be received if the irrigation demand was higher. Both RiverWare and WRMM used various expanded irrigation schemes ranging between 2 times and 11 times the current irrigation demand to evaluate how that change affected the distribution of water.

4.5 Performance Indicators

A performance indicator (PI) is a metric that quantifies the effect of changing water availability on the use or value of water. Performance indicators were used to evaluate options by comparing modelled scenarios to the base case, in which operating procedures in the model are close to the actual operating procedures that took place over the time period 1982 – 2014. PIs were developed in conjunction with the Aquatic Ecosystem TWG and the Socio-economic Analysis TWG to evaluate the potential impacts of different water management scenarios on three main areas of interest:

- receipt of entitlements
- impacts on irrigation
- aquatic ecosystem health.

4.5.1 Receipt of Entitlements

Four performance indicators were developed to evaluate the impact of different scenarios on the receipt of entitlements:

- Canada's receipt of entitlement of the St. Mary River at the International Boundary
- United States' receipt of entitlement of the St. Mary River at the International Boundary
- Canada's receipt of entitlement of the Milk River at the International Boundary

- United States' receipt of entitlement of the Milk River at the International Boundary.

Any of the following situations were considered an *improvement* in receipt of entitlement:

- The change in annual acre-feet received was greater than 5 percent of average annual entitlement (averaged over the study period)
- The change in percent entitlement received was greater than 5 percent
- The scenario resulted in 100 percent of the entitlement met.

The following situations were considered a *decrease* in receipt of entitlement:

- The decrease in annual acre-feet received was greater than 5 percent for the average annual entitlement
- The decrease in percent entitlement received was greater than 5 percent
- The scenario resulted in the country receiving less than 100 percent of its entitlement, when the base case resulted in the country receiving 100 percent or more.

Five percent of the average annual entitlements are:

- United States St. Mary River: 12,800 acre-ft (15,800 dam³)
- Canada St. Mary River: 18,600 acre-ft (23,000 dam³)
- United States Milk River: 3,375 acre-ft (4,165 dam³)
- Canada Milk River: 1,790 acre-ft (2,210 dam³).

Importantly, if the scenario resulted in a decrease in annual volume received, but the base case and the scenario both resulted in greater than 100 percent of the entitlement received, this was classified as no change instead of a decrease in entitlement received.

4.5.2 Impacts on Irrigation

The SEA TWG conducted studies in both Canada and the United States to better understand the role of agriculture and economics of the areas. The access to reliable and sufficient water to irrigate in the St. Mary and Milk River Basin directly correlate the economic productivity to each area. To assess how different scenarios would affect irrigation, fifteen performance indicators were developed to evaluate all modelled scenarios on irrigation communities in Canada and the United States: 1) Canadian St. Mary River irrigators, 2) Canadian Milk River irrigators, and 3) US Milk River irrigators. Five performance indicators were developed for each of the three communities, one performance indicator for each month of May, June, July, and August; and one for the combined period of May – August.

The performance indicators for Canadian St. Mary River irrigators are based on the change in flow across the International Boundary. When the change in May–August flow is greater than **30,000 acre-feet** (37,000 dam³), the year was classified as an improvement from the base case. If the decrease in flow across the International Boundary (IB) between the scenario and base case was greater than **30,000 acre-feet**, the year was then classified as a reduction in scenario performance from the base

case. **30,000 acre-feet** is approximately 10 percent of the average May- August flow of the St. Mary River across the IB for the base case scenario across the modelled water years (1982–2014). The performance indicator for each individual month was based on a change of 7,500 acre-feet (9,300 dam³). When the change in the total monthly flow across the IB was greater than 7,500 acre-feet, the month was considered an improvement from base case. When the decrease in monthly total flow across the IB was greater than 7,500 acre-feet, the month was classified as a reduction in performance. 7,500 acre-feet is approximately 9 percent of average flow at the IB in May, 6 percent of average flow in June, 10 percent of average flow in July, and 25 percent of average flow in August.

The performance indicator for the Canadian Milk River irrigators was based on irrigation shortages. Irrigation shortage is the difference between irrigation demands and the flow that is diverted for irrigation. If the irrigation shortage of the scenario decreased compared to the shortage under the base case, then the month or year was considered an improvement of scenario performance. If the shortage increased under the scenario compared to the base case, then the performance of the scenario was classified as a decrease in scenario performance.

The scenario performance indicator for the US Milk River users was based on the change in inflow to Fresno reservoir from May through August. When the change in May–August inflow was greater than **20,000 acre-feet** (24,700 dam³), the year was classified as an improvement from the base case. If the decrease in Fresno inflow between the scenario and base case was greater than **20,000 acre-feet**, the year was then classified as a reduction in scenario performance. **20,000 acre-feet** is approximately 11 percent of the average May-August Fresno inflow for the base case scenario across the modelled water years (1982–2014). The performance indicator for each individual month was based on a change of 5,000 acre-feet (6,200 dam³). When the change in the total monthly inflow to Fresno reservoir was greater than 5,000 acre-feet, the month was considered an improvement from base case. When the decrease in monthly total inflow to Fresno was greater than 5,000 acre-feet, the month was classified as a reduction in performance. 5,000 acre-feet is approximately 11 percent of average May inflow, 9 percent of average June inflow, 12 percent of average July inflow, and 15 percent of average August inflow.

4.5.3 Aquatic Ecosystem Health

Three performance indicators were developed for aquatic ecosystem health (AEH), all of which were developed for a threatened species of fish in the St. Mary River, the bull trout. This PI was developed at the request of and with the support of Indigenous communities in the basin. Bull trout is a key indicator species of aquatic ecosystem health. The PIs represented bull trout population growth rate in July, August, and September. Population growth rates were modeled as a function of average monthly flow (Muhlfield and Cline 2024). The bull trout population PI was classified as declining if the growth rate was less than 0.95, stable if the growth rate was between 0.95 and 1.05, and increasing if the growth rate was greater than 1.05. While other potential ecosystem PIs were considered (for example, cottonwood trees were identified in discussions with Indigenous communities), there was not enough information or time to develop additional aquatic ecosystem health performance indicators. Additional data collection and modelling would be needed for development of additional PIs.

4.6 Visualization Tool

The Data Visualization Tool synthesized a wealth of information coming from the water management models, summarizing millions of data points to thousands of plots, resulting in a useful means for exploring the implications of the modelled scenarios on points of interest to Study participants and board members. The following text and figures provide examples of the key visuals that were available through the tool; specific model results are discussed in more detail in Section 5. As an overall synopsis of the model results, Figure 13 shows the summary of all PIs for all modelled scenarios from one of the water management models. The various modelled scenarios are listed across the top columns, while the performance indicators are shown in the rows. Performance Indicator scores are color-coded (shading key on the right side of Figure 13), with green shading representing positive/improvement (darker shading signifies higher PI score and greater improvement), and tan/brown shading indicating negative consequences (again, darker shading signifies stronger negative impacts). The number in each box represents the performance indicator score (number of years) for each modelled scenario.

Performance Indicator	850 Canal	Capped Credit	Capped Credit with 850 CFS Canal	Forks Reservoir	Forks Reservoir and 850 Canal	Forks Reservoir with Increased Acreage	Forks Reservoir with Increased Acreage and 850 Canal	Lower St Mary Lake	Lower St Mary Lake with 850 Canal	Lower St Mary Lake with Capped Credit	Lower St Mary Lake with Capped Credit 850 Canal	Miners Coulee	Miners Coulee with 850 Canal	Miners Coulee with Capped Credit	Miners Coulee with Capped Credit and 850 Canal	Modified Annual Balancing	Modified Annual Balancing with 850 Canal	No Cap Credit	No Cap Credit with 850 Canal	Upper and Lower St Mary Lake	Upper and Lower St Mary Lake with 850 Canal
CA Entitlement Receipt: Milk	0	15	15	33	33	33	33	0	0	15	15	26	26	26	26	15	15	15	15	0	0
U.S. Entitlement Receipt: Milk	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CA Entitlement Receipt: St. Mary	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-7	-13	0	0	0	0
U.S. Entitlement Receipt: St. Mary	17	20	32	0	17	0	17	13	28	20	32	0	17	20	32	19	29	22	32	20	32
Bull Trout Growth Rate (July)	-4	0	-7	0	-4	0	-4	1	-4	0	-6	0	-4	0	-7	0	-8	0	-8	1	-5
Bull Trout Growth Rate (Aug)	0	-14	-8	0	0	0	0	0	0	-12	-9	0	0	-14	-8	-18	-12	-15	-10	0	0
Bull Trout Growth Rate (Sept)	0	-6	-1	0	0	0	0	0	0	-7	-5	0	0	-6	-1	-13	-7	-11	-6	0	0
CA Irrigation: St. Mary (May-Aug)	-10	0	-14	0	-10	0	-10	0	-12	-2	-12	0	-10	0	-14	-3	-20	0	-14	0	-12
CA Irrigation: St. Mary (May)	-1	-11	-20	0	-1	0	-1	-2	-5	-5	-9	0	-1	-11	-20	-15	-22	-10	-20	-2	-5
CA Irrigation: St. Mary (June)	-17	10	-18	0	-17	0	-17	-5	-19	8	-19	0	-17	10	-18	11	-22	12	-18	-5	-19
CA Irrigation: St. Mary (July)	-12	-4	-13	0	-12	0	-12	1	-12	-3	-13	0	-12	-4	-13	-11	-16	-8	-14	1	-12
CA Irrigation: St. Mary (Aug)	0	-14	-8	0	0	0	0	0	0	-11	-9	0	0	-14	-8	-22	-12	-18	-10	0	0
CA Irrigation: Milk (May-Aug)	0	29	29	29	29	33	33	0	0	29	29	29	29	29	29	29	29	29	29	0	0
CA Irrigation: Milk (May)	0	11	11	11	11	33	33	0	0	11	11	11	11	11	11	11	11	11	11	0	0
CA Irrigation: Milk (June)	0	17	17	17	17	33	33	0	0	17	17	17	17	17	17	17	17	17	17	0	0
CA Irrigation: Milk (July)	0	29	29	29	29	31	31	0	0	29	29	29	29	29	29	29	29	29	29	0	0
CA Irrigation: Milk (Aug)	0	29	29	29	29	33	33	0	0	29	29	29	29	29	29	29	29	29	29	0	0
U.S. Irrigation: Fresno (May-Aug)	19	0	21	-1	16	-4	13	0	20	1	21	0	19	0	23	2	26	1	21	0	20
U.S. Irrigation: Fresno (May)	23	8	31	-5	17	-8	12	3	27	8	31	0	22	8	30	9	28	9	31	6	29
U.S. Irrigation: Fresno (Jun)	32	0	32	-4	29	-7	22	0	32	0	32	0	32	0	32	0	33	0	32	0	32
U.S. Irrigation: Fresno (July)	23	0	24	-1	23	-3	23	0	24	1	25	0	23	0	25	1	25	0	25	0	24
U.S. Irrigation: Fresno (Aug)	1	2	3	0	1	0	1	2	1	3	4	0	1	2	3	4	7	3	4	3	1

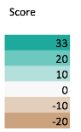


Figure 13. Performance Indicator output from Data Visualization Tool

The tool allowed Study Board members to focus on any of the performance indicators. For example, Figure 14 shows the US and Canadian Annual Entitlement Receipts of St. Mary water according to the RiverWare model with the 850 ft³/s canal. This figure shows that, for all modelled years, the United States' receipt of entitlement would increase in 17 out of 33 years, while Canada would continue to receive its annual entitlement in all 33 years. (As noted previously, "No Change" in these figures means less than 5% change.) These numbers correspond to the first and second rows in the first column of Figure 13. Due to the importance of receipt of entitlement being improved during drier years, the visualization tool also provided the same plots for the driest 50 percent of years and the driest 25 percent of years. The center and right side of Figure 14 illustrate that the models predict the canal rehabilitation to 850 ft³/s would improve the United States' entitlement receipt in five (5) of the 17 driest 50 percent of years, and two (2) of the nine (9) driest 25 percent of years.

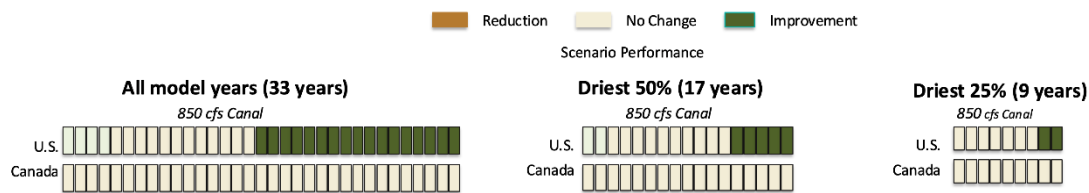


Figure 14. Comparison of annual entitlement receipts for the St. Mary River for the 850 ft³/s Canal scenario from the visualization tool

Figure 15 shows that further "zooming in" within the visualization tool allows users to get a better understanding of which years would have likely been impacted by the canal operating at its original design capacity of 850 ft³/s. In this case, the red bars in the top half of the figure show no change in the Canadian percent entitlement received because more than 100 percent of the entitlement was received each year. In the bottom part of the figure, each dark blue bar illustrates in which of the 17 years the United States would have received more of its annual entitlement, even if it still wouldn't have received 100 percent of its entitlement; the light blue bars represent no change.

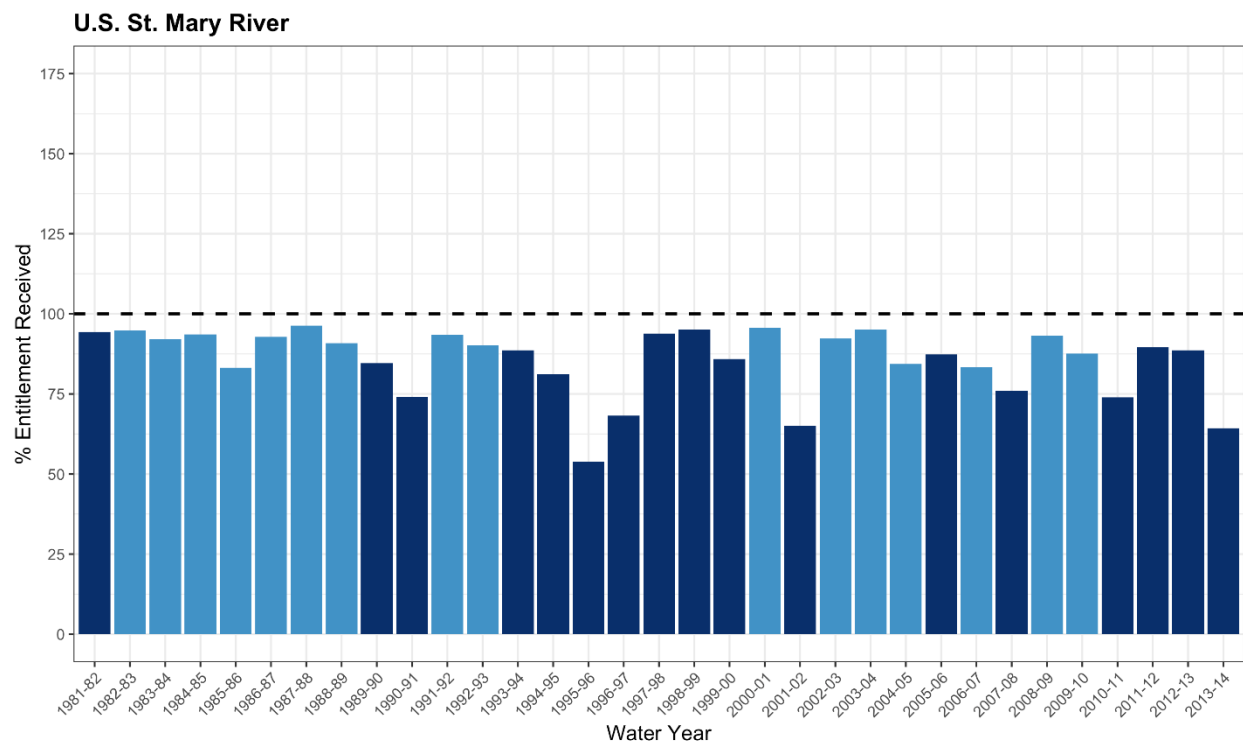
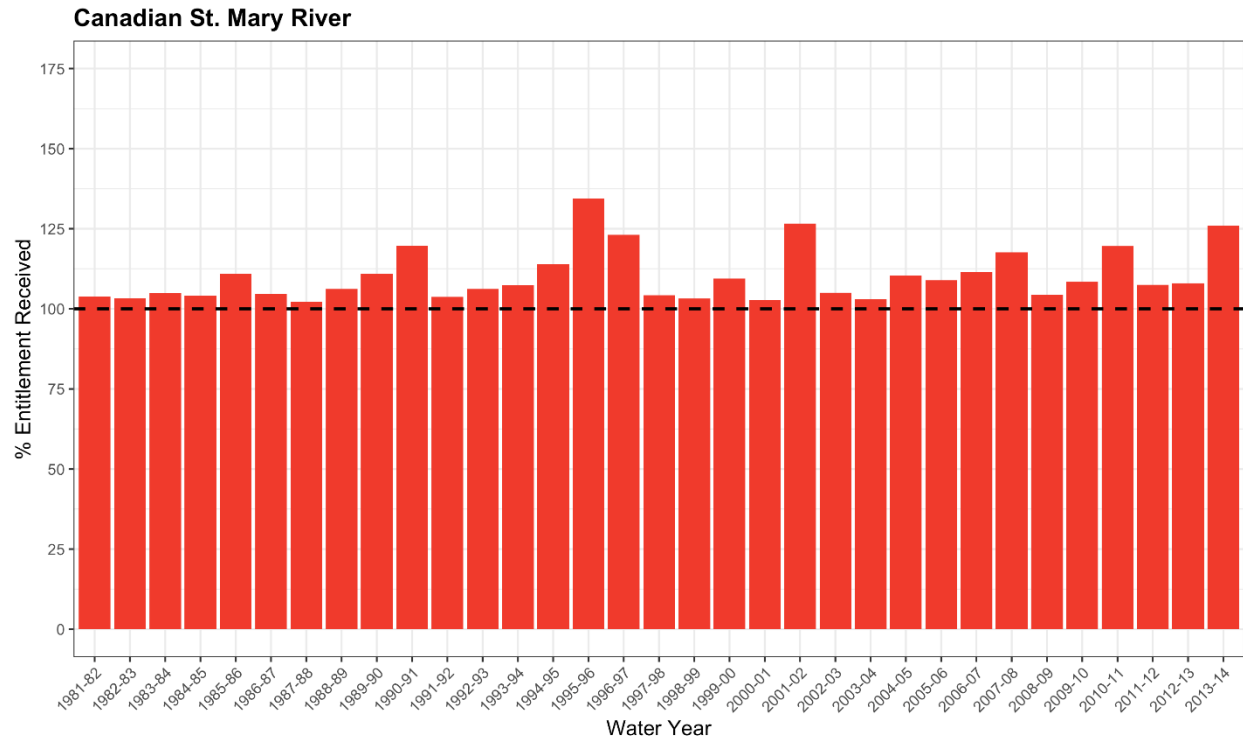


Figure 15. Detailed view of the receipt of entitlement performance indicator on the St. Mary River by year for Canada (top) and the United States (bottom) with the canal operating at 850 ft³/s

Figure 16 shows the more detailed information about the bull trout PI for July, August, and September for the 850 ft³/s canal scenario, corresponding to the fifth to seventh rows in the first column of the performance indicator summary plot shown in Figure 13. This scenario would result in a reduction in the bull trout PI during July for four (4) of the 33 years modelled. Among the driest 50% of years, one year would result in a reduction in the bull trout PI, with other years experiencing no significant change in this PI.

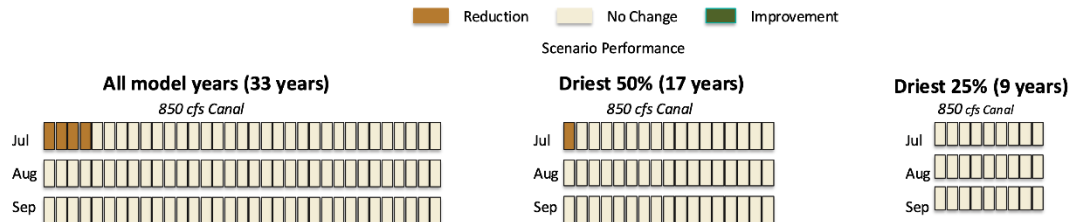


Figure 16. The bull trout performance indicator details with the canal operating at 850 ft³/s

Figure 17 shows more detailed information about RiverWare model estimates of the change in May to August inflows to Fresno Reservoir for each year from 1982 to 2014 if the canal were operating at 850 ft³/s capacity for all modelled years, the driest 17 of 33 modelled years, and the most dry 9 of 33 model years. This scenario results in a net increase in Fresno Reservoir inflows in 27 of the 33 years modelled; all four (4) of the years with small net decreases in inflows occurred during the driest 17 years modelled.

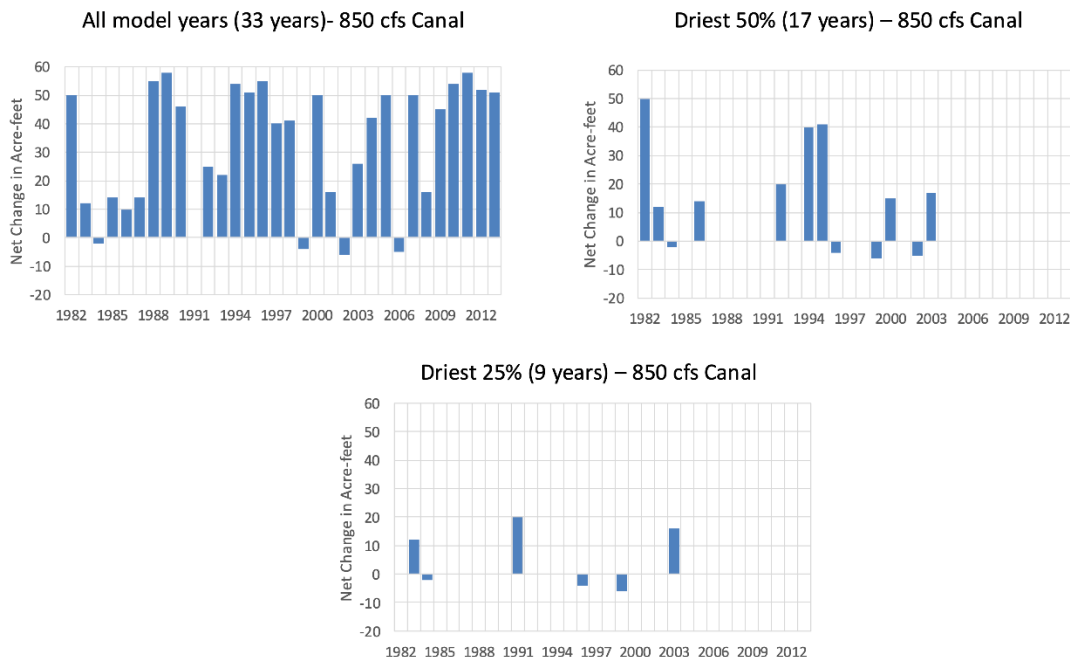
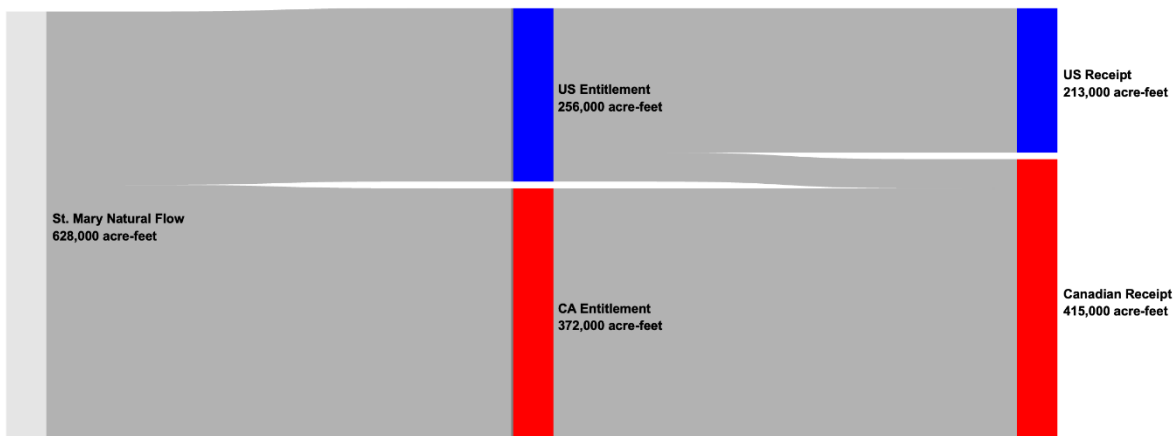


Figure 17. Modelled increases to Fresno Reservoir Inflow with the canal operating at 850 ft³/s

Figure 18 shows another type of summary diagram (called a Sankey Diagram) that the study team found useful in visualizing the model outputs. This diagram shows the natural flow for both rivers at the

international boundary locations on the far left, the entitlements to those natural flows to each country in the middle, and the modelled receipts of entitlements to each country on the far right. Comparing the center blue (US entitlement) and red (Canadian entitlement) bars with the right blue (US receipt) and red (Canadian receipt) bars provides a helpful summary of the model results. These Sankey diagrams were very useful for comparing scenarios with one-another. Figure 18 illustrates the entitlement received on an annual basis. Other diagrams were also developed (but not shown) to refine data on a smaller time scale and hydrologic situation (for example, dry years) to understand the entitlement receipt on a monthly balancing period, on average for the driest 25 percent, driest 50 percent of all years.

St. Mary River Allocation and Receipt with 850 Canal



Milk River Allocation and Receipt with 850 Canal

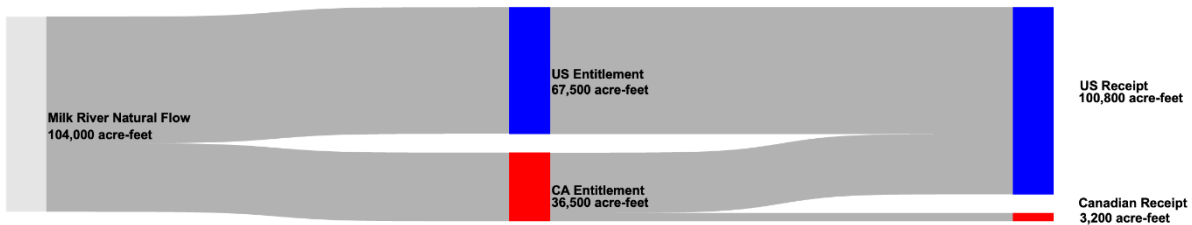


Figure 18. Sankey diagram for the modelled estimates of flow and receipt of entitlements with the canal operating at 850 ft³/s

The figures shown above are examples of output from the data visualization tool. Additional capabilities of the data visualization tool included the ability to download timeseries data and summary flow diagram data for each of the scenarios, which allowed more independent analysis by technical working group and Study Board members.

5 MODEL RESULTS

5.1 Climate Indicator Assessment

5.1.1 Background

An important way to understand how the climate is changing is by using standardized climate indices. These indices summarize complex climate information into measures that help explain how temperature, precipitation, and water availability are changing over time. They are commonly used to assess future water supply conditions and to inform long-term water management planning. In this study, 37 climate indicators developed by the World Meteorological Organization's Expert Team on Sector-Specific Climate Indices (ET-SCI) were used. These indicators capture changes in temperature extremes, patterns of precipitation, and overall water balance conditions. Together, they provide a comprehensive picture of how climate conditions relevant to water resources are evolving.

The analysis used climate datasets provided by Alberta Environment and Protected Areas (AEPA), applying the methodology developed by Thombiano et al. (2023) to both the St. Mary River and Milk River basins. The AEPA datasets include 15 climate model simulations that have been statistically downscaled and bias-corrected using outputs from the Coupled Model Intercomparison Project Phase 6 (CMIP6). These simulations cover both historical conditions (1950–2014) and future projections (2015–2100). To represent a broad range of possible future climates, two emissions scenarios were considered: SSP1-2.6, which reflects a low-emissions pathway, and SSP3-7.0, which represents a high-emissions pathway. Together, these scenarios span much of the uncertainty associated with future greenhouse gas emissions and climate change.

A workflow developed by Thombiano et al. (2023) was used to calculate the ET-SCI indices from daily temperature and precipitation data produced by the climate models. This workflow includes data preprocessing, index calculation, trend analysis, and assessment of uncertainty across the climate simulations. The temperature-related indices describe changes in hot and cold extremes, general temperature patterns, and heatwave characteristics. The precipitation-related indices describe both average and extreme precipitation behavior, as well as indicators related to water balance. Additional technical details are provided in the CHTWG Supplementary Document 2.1, with a summary of the key findings presented below.

5.1.2 Temperature Indicators

Table 7 provides a list of several temperature indicators for the basin (Supplementary Document 2.1 contains a complete list). Both the St. Mary River Basin and Milk River Basin exhibit strong historical and projected warming, with minimum temperatures (TNn) increasing at a faster rate than maximum temperatures (TXx). This pattern suggests that winters are warming more significantly than summers are becoming hotter, leading to fewer frost and ice days. Heatwave-related indicators, including HWF (heatwave frequency), HWD (heatwave duration), and SU (summer days count), show that extreme heat

events will become longer and more frequent across both basins. Figure 19 presents the multi-model ensemble projection of temperature extremes (TXx, TNx, TXn, TNn), for the Milk River Basin (denoted as MRB in this and subsequent figures) and the St. Mary River Basin (denoted as SMRB) under high-emission scenarios (SSP370, SSP585). The plots on the left side of the figure depict maximum values, while the plots on the right show minimum values. The consistent increase in annual maximum and minimum temperatures suggests that heat extremes will intensify, while cold extremes will decline sharply by the end of the century. Although warming trends are similar in both basins, results shows that the MRB is projected to experience a greater increase in tropical nights (TR – nights above 25 °C), as compared to the SMRB, under high-emission scenarios, indicating prolonged nighttime heat stress. This could have significant implications for ecosystem health and water demand in the MRB, which already experiences more variable seasonal temperatures.

Table 7. Temperature indicators for the St. Mary and Milk River basin (for a complete list, refer to the climate and water Supplementary Document 2.1)

TXx [°C]	Maximum value x of daily maximum temperature (TX) for each year
TNx [°C]	Maximum value x of daily minimum temperatures (TN) for each year
TXn [°C]	Minimum value n of daily maximum (TX) for each year
TNn [°C]	Minimum value n of daily minimum temperatures (TN) for each year

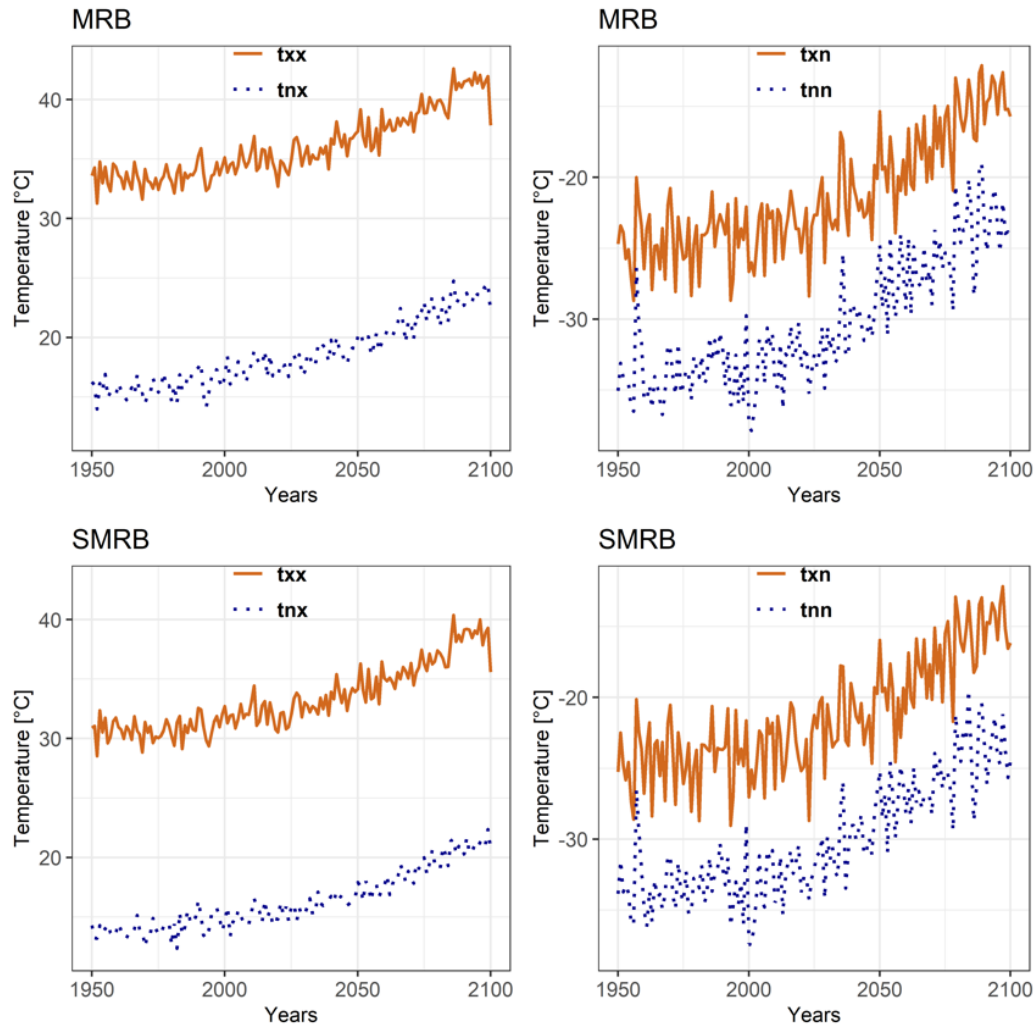


Figure 19. Projected average temperature maximum (left) and minimum (right) values for the Milk River basin (MRB top) and St. Mary River Basin (SMRB bottom)

5.1.3 Precipitation Indicators

Future changes in precipitation are more uncertain than changes in temperature, and the results do not show strong or consistent trends in either the St. Mary River Basin or the Milk River Basin. While some climate models project modest increases in annual total precipitation and in short-duration extreme precipitation events, there is considerable disagreement among the models. This variability reduces confidence in identifying a clear long-term precipitation trend. The Milk River Basin, which is naturally drier, shows especially large fluctuations across precipitation projections. This wide range of model outcomes makes it difficult to draw firm conclusions about how overall precipitation may change in the Milk River Basin over time. In contrast, the St. Mary River Basin, which is influenced by higher elevations, shows slightly better agreement among climate models, particularly with respect to increases in precipitation intensity rather than total annual amounts. Figure 20 presents the multi-model ensemble projections for annual total precipitation (PRCPTOT) and maximum daily precipitation (RX1day) for both

the SMRB and the MRB. The large spread in the projected trends shown in this figure highlights the substantial uncertainty associated with future precipitation changes. This uncertainty underscores the importance of further hydrological analysis to better understand how potential changes in precipitation may affect runoff, streamflow, and water availability in both basins.

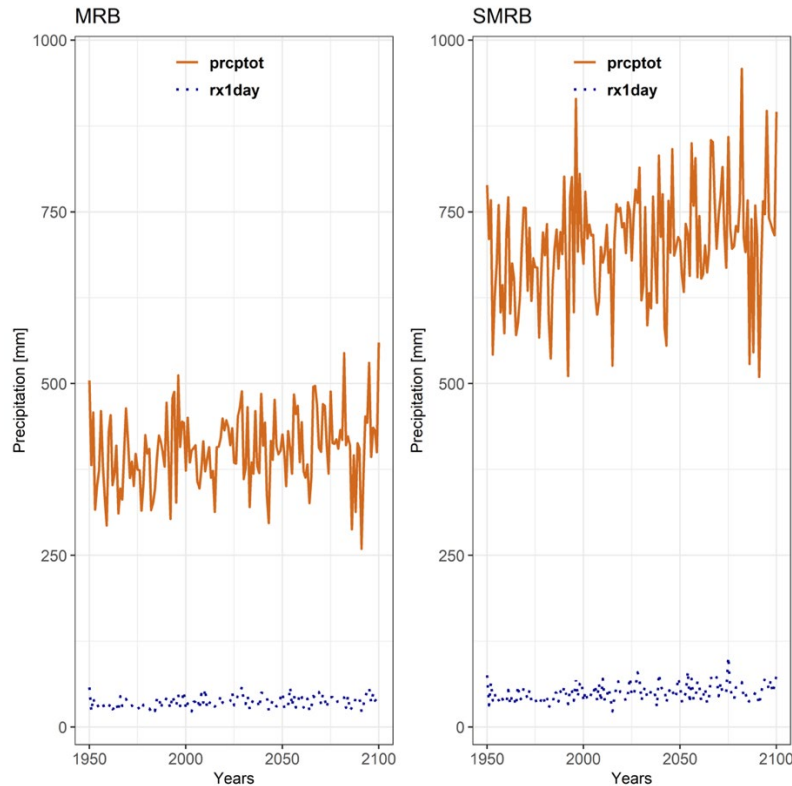


Figure 20. Projected precipitation amounts for the Milk River basin (MRB) and St. Mary River Basin (SMRB).

The annual time series of total precipitation (prcptot) and of maximum 1-day precipitation (rx1day) are averages from three multimodel (BCC-CSM2-MR, EC-Earth3-Veg, and IPSL-CM6A-LR) simulations associated to the SSP370 future climate high emission scenario.

5.1.4 Drought and Water Balance Indicators

Projections indicate that water availability is likely to decrease in both the St. Mary River Basin and the Milk River Basin, particularly during the summer months and across the full water year. This is reflected in the drought indices Aug_SPEI3, which represents summer water stress, and Sep_SPEI12, which reflects drought conditions over the entire water year. Under high-emission scenarios (SSP3-7.0 and SSP5-8.5), substantial reductions in water availability are projected, with strong and consistent agreement across the climate models evaluated. Figure 21 illustrates projected trends in the Standardized Precipitation Evapotranspiration Index (SPEI) for the Milk River Basin. These results point to increasing water stress throughout the 21st century. Both near-future conditions (2041–2070) and far-future conditions (2071–2100) show a clear shift toward more severe and persistent drought, with the strongest impacts occurring during the summer period when water demand is highest. The Milk

River Basin is particularly sensitive to these changes because it relies heavily on seasonal runoff, rather than sustained base flows. This dependence makes the basin more vulnerable to extended droughts and prolonged periods of very low river flows. As a result, the projected increase in water stress raises concerns about future agricultural and municipal water shortages, especially during the summer irrigation season when water demand typically peaks.

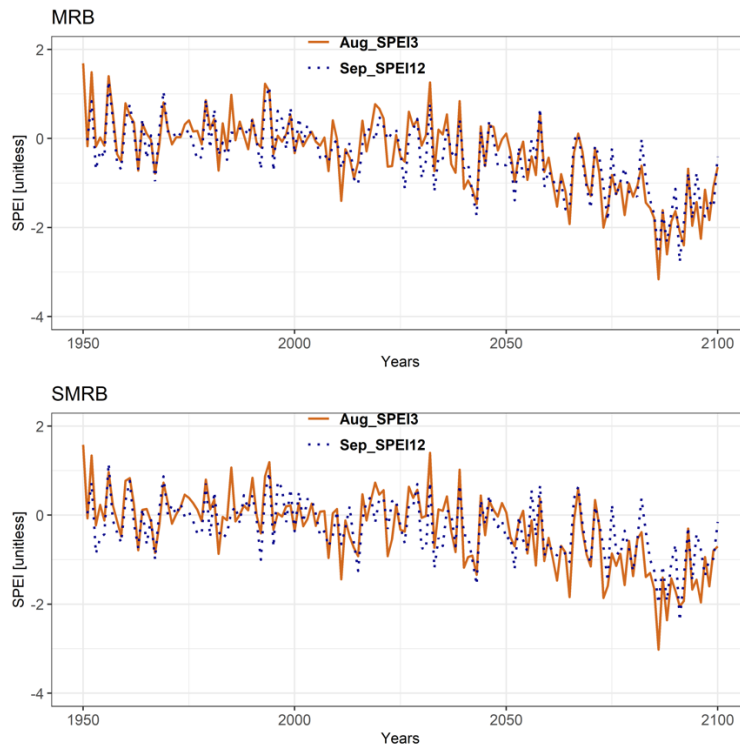


Figure 21. Projected changes in water balance (represented by the standardized precipitation evapotranspiration index SPEI) for the Milk River basin (MRB) and St. Mary River Basin (SMRB).

The annual time series of the SPEI at 3-months' time scale for August (Aug_SPEI3) and at 12-months' time scale for September (Sep_SPEI12) are presented.

5.1.5 Hydrological and Water Resource Implications

Both basins will face increasing challenges in water resource management due to shifting hydroclimatic conditions (Table 8). The St. Mary River Basin's snowmelt-driven regime is projected to experience earlier peak flows, affecting irrigation timing and reservoir operations. The Milk River Basin, which relies more on ephemeral flows, is projected to experience greater uncertainty in seasonal water availability, which could make it more difficult to meet water demands without additional storage or adaptation measures.

Overall, the Milk River Basin faces greater drought risk and will require proactive water storage and conservation strategies to mitigate its increased vulnerability to seasonal variability. The St. Mary River's reliance on snowmelt and glacial contributions will necessitate changes in irrigation scheduling and

reservoir management. Both basins will require enhanced monitoring and adaptive water policies to address the increasing unreliability of their water supplies.

Table 8. Summary of possible hydrological implications in the basin

Indicator	St. Mary River Basin (Mountain-fed)	Milk River Basin (Runoff-dependent)
Temperature Increase	Strong warming, slightly less extreme warming of “tropical” nights	Strong warming, more tropical nights under high emissions
Precipitation Trends	Slight increase, but no significant change	More variability, less confidence in trends
Drought Risk	Increased summer deficits, but moderated by higher elevation precipitation	Higher risk of prolonged drought, greater sensitivity to seasonal variability
Water Availability	Declining snow contributions, peak flow timing shift	Seasonal runoff variability, higher risk of extreme low-flow conditions

The findings show that warmer winters accelerate snowmelt, shifting peak river flows earlier in the year and reducing late-season water availability. The projected decrease in summer water balance poses significant risks for irrigation, municipal supply, and ecosystem health. Without adaptive measures, competition for water resources will intensify, affecting economic and environmental sustainability.

5.2 Hydrologic Model Results

5.2.1 Historical Streamflow

The analysis of modelled 2015-2100 future data relative to that for 1981-2015 shows a significant increase in streamflow, especially from April to December, indicating a shift toward wetter conditions in warmer months for the Eastern Milk River Basin, whereas for the Western Milk River Basin, seasonal shifts were observed such that winter flows were increasing but late summer flows were declining. The St. Mary River Basin exhibits the same seasonal shifts as the Western Milk River Basin (increased winter flows but declining flows in late summer and fall), reflecting a pronounced east-west divide in hydrological behavior, likely driven by regional climate and watershed differences. Analysis of droughts indicates that from 1981 through 2015, droughts in the Milk River Basin were more frequent, longer, and more severe than in the St. Mary River Basin, with some stations (e.g., Milk River at Eastern Crossing) having had extreme droughts lasting up to 31 months.

As described in Section 2, four distinct hydrological models were used, enabling the cross-validation of modelling results. Each model contributed unique strengths, with some offering improved simulation accuracy in prairie environments. However, significant uncertainties remain, particularly in the Milk River Basin, due to limited observational data and complex flow regulation. Based on comparisons of model output with validation data, the HYPE model had the best performance for the St. Mary and Milk River Basins.

The models were compared only during the irrigation season because this is when water management decisions matter most, and when the river system is best represented by available data. During this period, water demand is highest, and snowmelt from the mountains, water transferred through canals, and summer rainfall are the main factors controlling river flows. Winter conditions were excluded because ice and very low flows make measurements less reliable. Focusing on the irrigation season therefore gives the clearest and most practical way to judge how well the models perform. Model performance was tested using several standard evaluation tools that all produced similar results. Overall, the HYPE model consistently performed the best, especially at key water-sharing locations, showing that it reliably matched observed river flows. These results were consistent across different evaluation methods, giving confidence that HYPE provides the most reliable representation of irrigation-season flows for management and decision-making purposes.

The results from the HYPE model, shown in Figure 22 and Figure 23, highlight the median and 25th – 75th percentile flows from the HYPE model, compared to naturalized flow for the St. Mary and Milk Rivers.

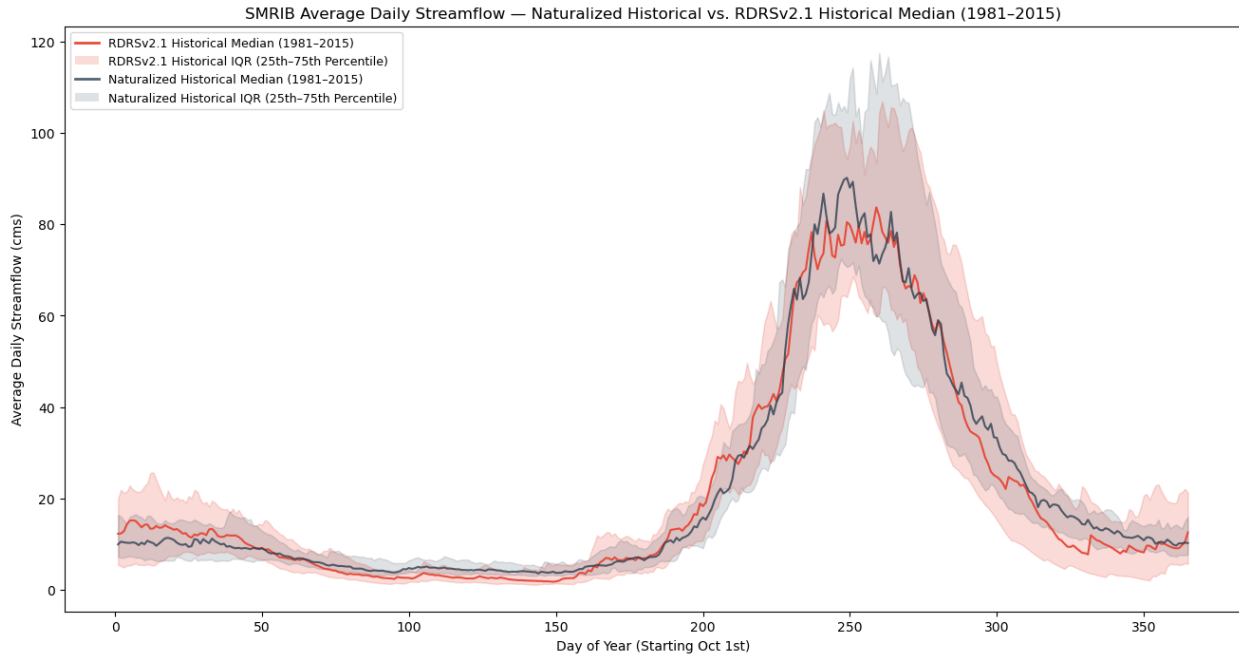


Figure 22. Median and inter-quartile flows for the HYPE model compared to naturalized daily flows from 1981 – 2015 for the St. Mary River at the International Boundary

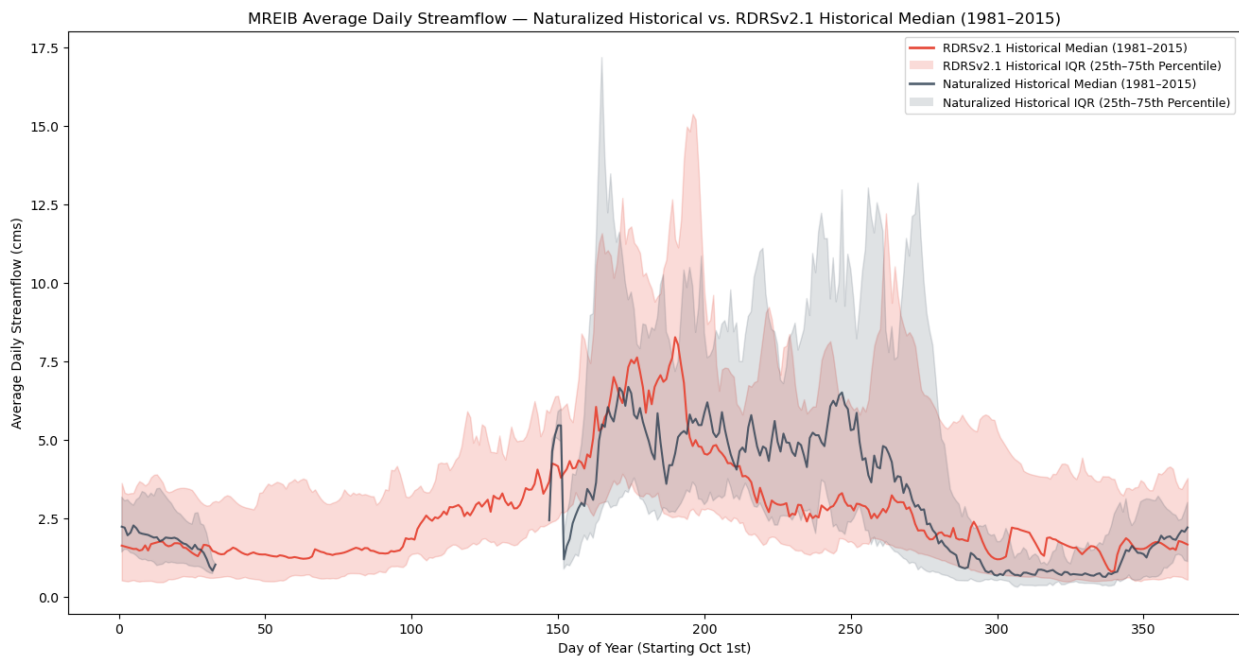
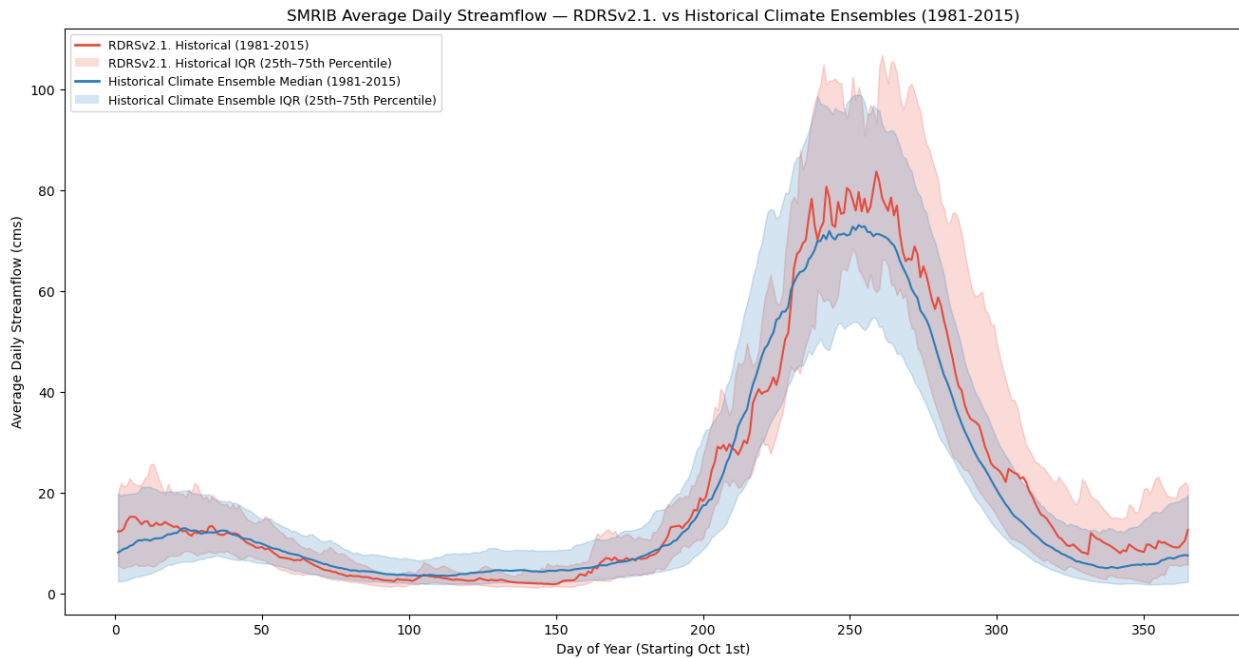
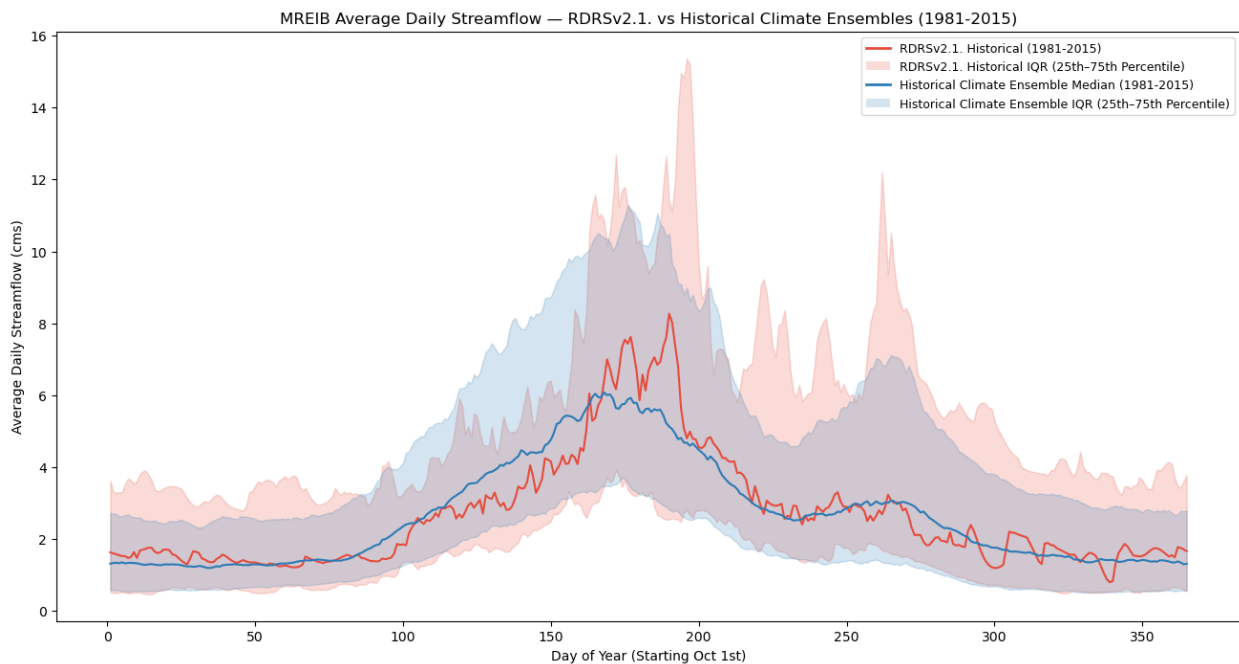


Figure 23. Median and inter-quartile flows for the HYPE model compared to naturalized daily flows from 1981 – 2015 for the Milk River at the Eastern Crossing

- 1 Figure 24 and Figure 25 shows the comparisons between the Regional Deterministic Reforecast System
 2 (RDRS) historical reanalysis and the climate model historical periods from 1981 – 2015, along with the
 3 25th – 75th percentiles of flow, illustrating that the two are comparable to one another.



- 4
 5 **Figure 24. Median and inter-quartile flows for the HYPE model comparing reanalysis flows and historical climate flows**
 6 **for daily flows from 1981 – 2015 for the St. Mary River at the International Boundary**



- 7
 8 **Figure 25. Median and inter-quartile flows for the HYPE model comparing reanalysis flows and historical climate flows**
 9 **for daily flows from 1981 – 2015 for the Milk River at the Eastern Crossing**

This modelling framework provides a robust foundation for long-term transboundary water management and policy development between Canada and the United States.

5.2.2 Potential Future Streamflow

Hydrological and hydroclimate indicators provided a comprehensive picture of the evolving water regime in the St. Mary and Milk River basin (Figure 26, Figure 27). The St. Mary River basin, which is primarily snowmelt-driven, is expected to experience earlier runoff and reduced snowpack. The Milk River basin, characterized by prairie hydrology and ephemeral flows, is projected to face delayed peak flows and increased drought risk. Temperature trends indicate strong warming across both basins, with minimum temperatures rising faster than maximum temperatures, leading to warmer winters and longer growing seasons. Heatwaves are expected to become more frequent and intense, particularly in the Milk River basin. The shift from snowmelt-dominated hydrographs to more rainfall-driven runoff has implications for irrigation timing, reservoir operations, and seasonal water availability.

In the St. Mary basin, although peak flows may decline, overall water availability could remain stable or potentially increase slightly. In the Milk River basin, which shows greater uncertainty in precipitation projections, the centroid of annual runoff is expected to shift modestly later in the year, by approximately five days. At present, the Milk River basin typically experiences two peak flow periods—one associated with snowmelt and another driven by summer storm events. However, future projections show reduced streamflow during the snowmelt period with peak flows occurring in the summer months. This shift toward a single peak flow in the Milk River Basin would result in peak flows occurring significantly later in the year, by approximately 90 days.

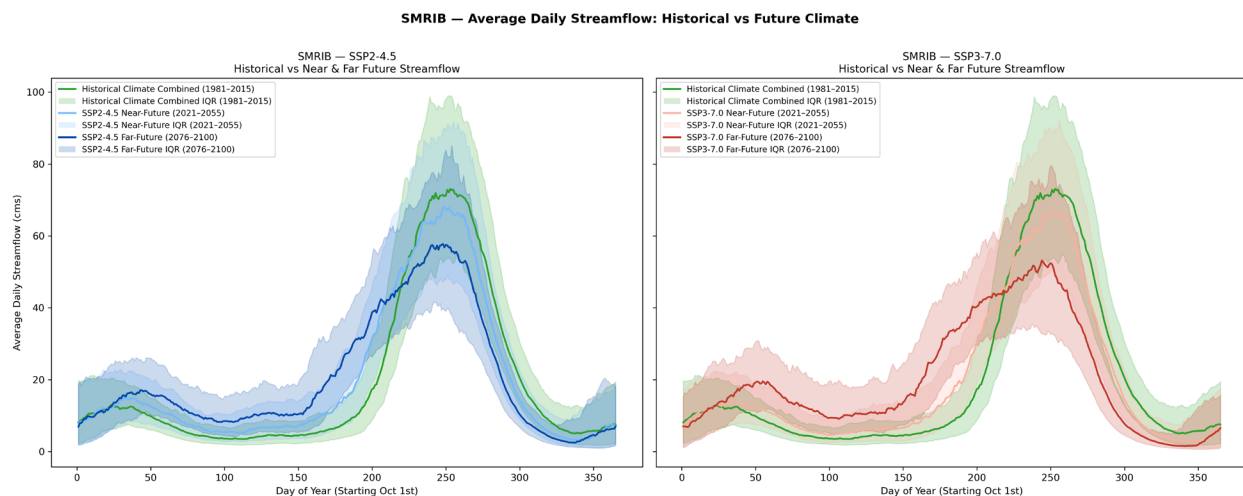


Figure 26. Median and inter-quartile flows for the HYPE model comparing historical and future climate flows for daily flows for the St. Mary River at the International Boundary

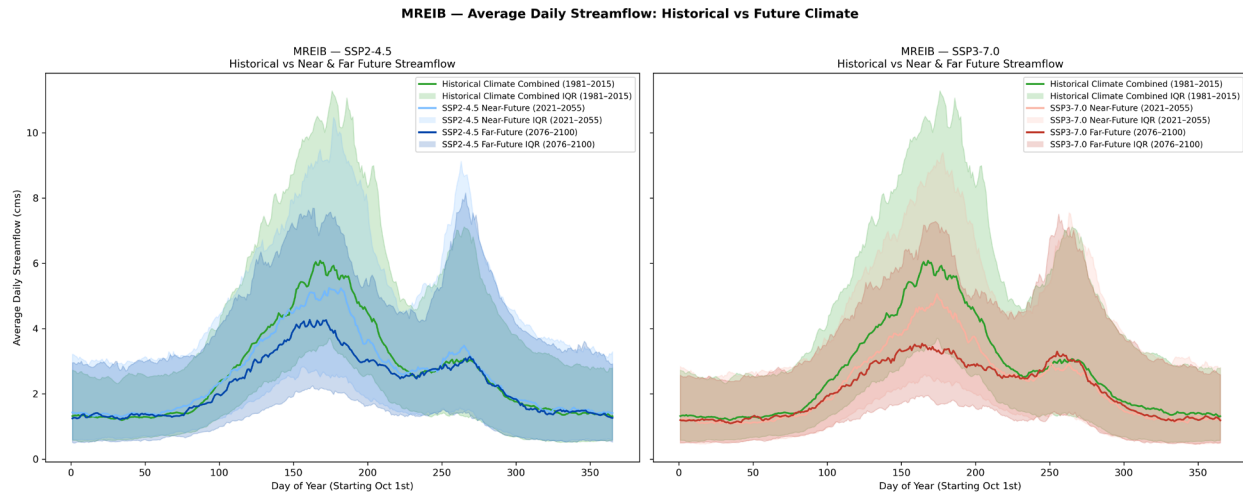


Figure 27. Median and inter-quartile flows for the HYPE model comparing historical and future climate flows for the Milk River at the Eastern Crossing

5.3 Water Management Model Results for Receipt of Entitlements

5.3.1 Historical Streamflow and Climate

The two water management models, WRMM and RiverWare, were run in parallel to examine the potential effects of various water management and infrastructure options. At the time of the study, after comparing results from these two primarily independently developed models, the Study Board recognized that the use of two models greatly enhanced the board's understanding of receipt of entitlements in the system and increased confidence in the models' results.

When considering entitlements alone, the PIs generally show that there are several options that can be employed such that the United States and Canada can improve receipt of their entitlements through administrative and structural options. The United States can improve the receipt of its entitlement on the St. Mary River through any of the administrative options considered, increased storage, or improved canal conveyance to its original design capacity of 850 ft³/s. Canada can improve its receipt of entitlement on the Milk River through any of the administrative options considered or more storage. Either one would help ensure Canada is better able to access its entitlement, but the combination of more flexible administrative options with additional storage would result in the most improvement in Canada's access to entitlement on the Milk River.

An analysis of the water management modelling outputs shows that certain scenarios offer advantages to both countries in terms of improving their access to their share of water. The three viable administrative options (cap credit, no cap credit, and modified annual balancing) perform comparably in improving each country's access to its entitlement. All three administrative options allow Canadian Milk River users access to up to 4,000 acre-feet of US St. Mary water flowing in the Milk River canal if the natural flow of the Milk River is lower than the demand. The modified annual balancing administrative

option is simpler to implement compared to the others, while providing greater administrative flexibility and resilience in the system.

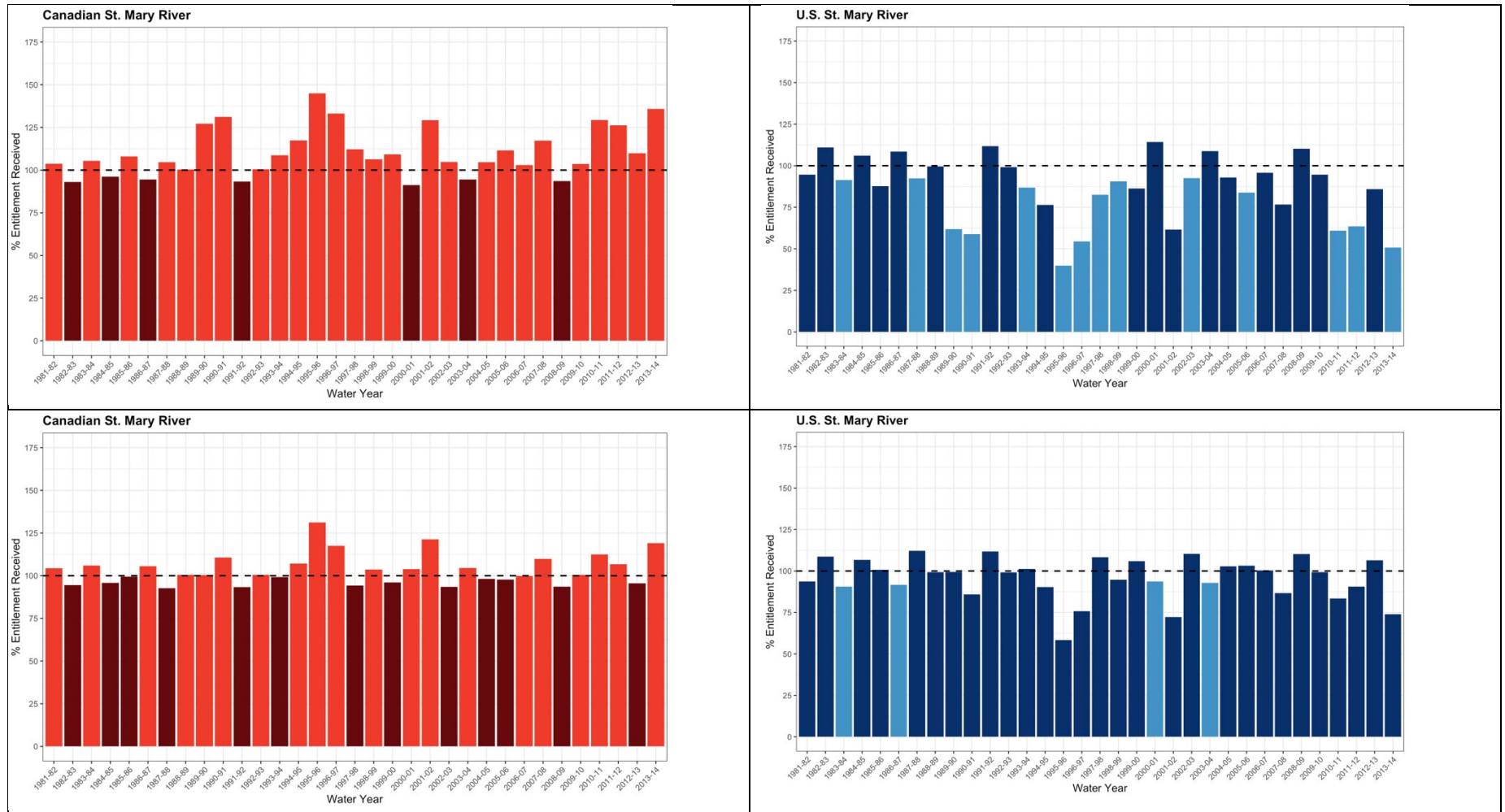
As shown in the top two sub-figures of Figure 28, with the St. Mary Canal capacity at 600 ft³/s, the modelling results indicate that the modified annual balancing framework provides a modest but meaningful increase to overall US receipt of entitlement while enabling Canadian Milk River irrigators to reliably meet their existing irrigation demand. On the St. Mary River, implementation of the modified annual balancing administrative option would ensure that Canadian St. Mary River irrigators can continue to access their full entitlement in most years and would incrementally increase the United States' access to its entitlement.

As shown in the bottom two sub-figures of Figure 28, the ability of the United States to access its full entitlement more consistently on the St. Mary River requires the 850 ft³/s canal in addition to implementing the modified annual balancing administrative option. Rehabilitation of the US St. Mary Canal to its original engineered design capacity of 850 cubic feet per second would have a substantial positive effect on the ability of the United States to more fully access its entitlement of St. Mary water by providing the most additional water to Fresno Reservoir during irrigation season compared to any other changes considered. In wetter years (median or greater annual precipitation), model results indicated an estimated additional 35,000-60,000 acre-feet (43,000 – 74,000 dam³) of St. Mary River water could be delivered into the Milk River system for use by the US Milk River Project or potentially by individual Canadian Milk River irrigators in conjunction with administrative options. There is a corresponding loss of over-delivery of water to Canada on the St. Mary system.

The modelling also showed the value of adding control structures on Upper and Lower St. Mary Lakes. This option would provide approximately 16,640 acre-feet (20,500 dam³) of additional active storage in the United States. This measure would enhance basin-wide operational flexibility, while increasing drought and environmental resilience. Under a 600 ft³/s (17 m³/s) canal capacity, the incremental benefit of this added storage is expected to be marginal, as conveyance capacity rather than storage is limiting. Under an 850 ft³/s canal capacity, the additional storage could meaningfully improve water availability for United States irrigators during drier periods.

While the administrative options help improve access to water entitlement, the water management modelling showed that for Canada to access its full entitlement on the Milk River, increased storage is required. Without additional storage, access to entitlement remains constrained by hydrologic variability and operational limitations. The Board evaluated two different Canadian Milk River storage options: on-channel (Forks Reservoir) and off-channel (Miners Coulee).

1



2 Figure 28. Impact on US and Canadian entitlement receipt for the Modified Annual Balancing Scenario (top two sub-figures) and the Modified Annual Balancing
 3 Scenario with an 850 ft³/s capacity canal (bottom two sub-figures)

4

As noted earlier, the modified annual balancing administrative option allows Canadian Milk River receipts to fully support current irrigation demand but adds limited resiliency. Miners Coulee could be used to provide increased interannual resiliency as well as a modest improvement to access to entitlement. The Forks Reservoir would allow Canadian Milk River receipts to approach full entitlement, allowing increased access and contributing to additional resilience to the Milk River basin. Figure 29 shows that Canada would be able to increase its access to Milk River flows from 9 percent to 83 percent of its entitlement, when including the Forks Reservoir and expanded irrigated acreage.

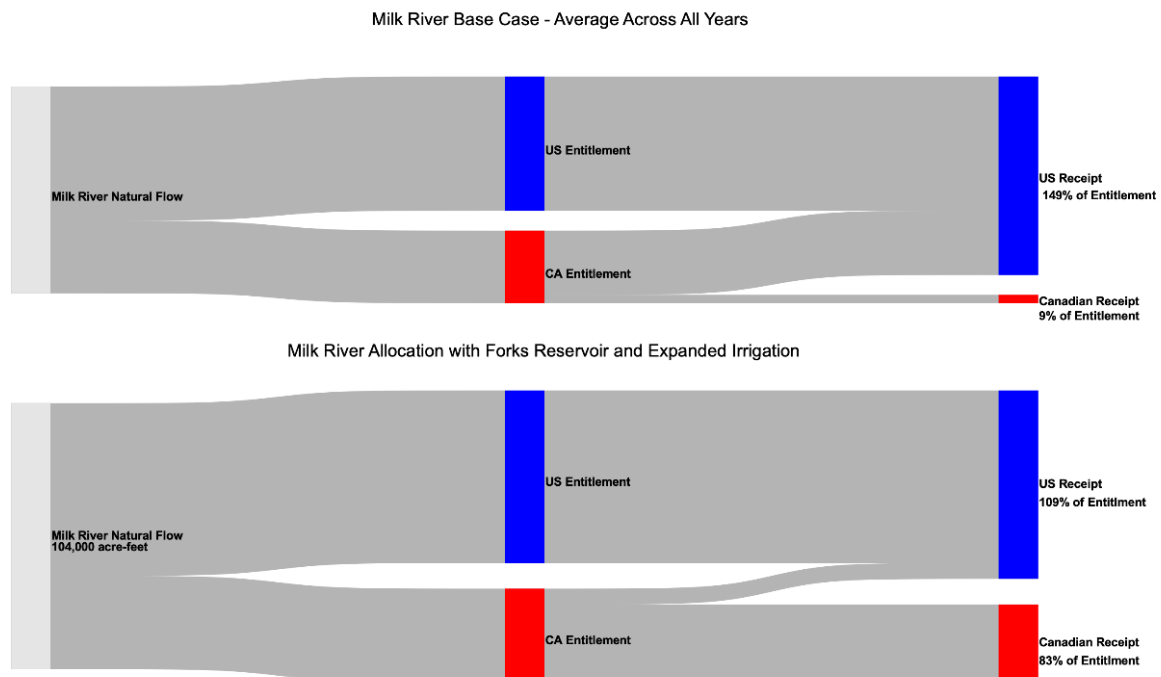


Figure 29. Potential impact on receipts of entitlements with the Forks Reservoir with expanded acreage

5.3.2 Comparison of Study Model Results with JIT Results

Model results from this study were compared with model results from simulations of similar scenarios by the Montana-Alberta Joint Initiative Team. The JIT used an earlier version of the WRMM used for this study. Results of seven similar scenarios were compared and were found to be fairly similar, with reasonable explanations for the slight differences. In much the same way that comparing the results from this study's two water management models inspired confidence in the results of each, the similarity of the Joint Initiative Team's results to the Study's results validated the modelling performed for this study.

5.3.3 Potential Future Streamflow and Climate

Water management model results incorporating potential future climate warming were developed by running a single future climate scenario to 2100 through the RiverWare model. The single climate scenario was selected by choosing the climate model trace that best represented the average (median) flows of both the St. Mary and Milk rivers from the full ensemble of future climate scenarios. All RiverWare structural, non-structural, and combined scenarios were run with this single future hydroclimate streamflow input. Performance indicators for this single run were then calculated for each of the scenarios.

Figure 30, Figure 31, and Figure 32 show the results of the receipt of entitlement performance indicators for the historic period, mid-century period, and late century period, respectively. In all three comparisons, the PIs are demonstrating the change from the base case run. The specific indicator values are slightly different from one period to the next, but they are consistent in what they show for each of the scenarios as far as positive and negative results.

	850 cfs Canal	Capped Credit	Capped Credit 850 Canal	Forks Reservoir	Forks Reservoir 850 Canal	Forks Reservoir Ex Acreage	Forks Reservoir Ex Acreage 850 Canal	Lower St. Mary Lake 850 Canal	Lower St. Mary Lake	Lower St. Mary Lake Capped Credit	Lower St. Mary Lake Capped Credit 850 Canal	Miners Coulee	Miners Coulee 850 Canal	Miners Coulee Capped Credit	Miners Coulee Capped Credit 850 Canal	Modified Annual Balancing	Modified Annual Balancing 850 Canal	No Cap Credit	No Cap Credit 850 Canal	Upper and Lower St. Mary Lake	Upper and Lower St. Mary Lake 850 Canal
	RiverWare	RiverWare	RiverWare	RiverWare	RiverWare	RiverWare	RiverWare	RiverWare	RiverWare	RiverWare	RiverWare	RiverWare	RiverWare	RiverWare	RiverWare	RiverWare	RiverWare	RiverWare	RiverWare	RiverWare	RiverWare
U.S. Entitlement Receipt: St. Mary	17	22	33	0	17	0	17	32	21	24	33	0	17	22	33	23	33	24	33	26	33
CA Entitlement Receipt: St. Mary	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-8	-8	0	0	0	0
U.S. Entitlement Receipt: Milk	0	0	0	0	0	-2	-2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CA Entitlement Receipt: Milk	0	9	9	9	9	33	33	0	0	9	9	9	9	9	9	9	9	9	9	0	0

Figure 30. Performance indicator results for receipt of entitlements for the historic period

	850 cfs Canal	Capped Credit	Capped Credit 850 Canal	Forks Reservoir	Forks Reservoir 850 Canal	Forks Reservoir Ex Acreage	Forks Reservoir Ex Acreage 850 Canal	Lower St. Mary Lake 850 Canal	Lower St. Mary Lake	Lower St. Mary Lake Capped Credit	Lower St. Mary Lake Capped Credit 850 Canal	Miners Coulee	Miners Coulee 850 Canal	Miners Coulee Capped Credit	Miners Coulee Capped Credit 850 Canal	Modified Annual Balancing	Modified Annual Balancing 850 Canal	No Cap Credit	No Cap Credit 850 Canal	Upper and Lower St. Mary Lake	Upper and Lower St. Mary Lake 850 Canal
	RiverWare	RiverWare	RiverWare	RiverWare	RiverWare	RiverWare	RiverWare	RiverWare	RiverWare	RiverWare	RiverWare	RiverWare	RiverWare	RiverWare	RiverWare	RiverWare	RiverWare	RiverWare	RiverWare	RiverWare	RiverWare
U.S. Entitlement Receipt: St. Mary	12	26	33	0	13	0	13	25	16	30	33	0	12	26	33	26	33	27	33	29	33
CA Entitlement Receipt: St. Mary	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-5	-7	0	0	0	0
U.S. Entitlement Receipt: Milk	0	0	0	0	0	-2	-2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CA Entitlement Receipt: Milk	0	13	13	13	13	33	33	0	0	13	13	12	12	13	13	13	13	13	13	0	0

Figure 31. Performance indicator results for receipt of entitlements for the mid-century period (2042 – 2074)

	850 cfs Canal	Capped Credit	Capped Credit 850 Canal	Forks Reservoir	Forks Reservoir 850 Canal	Forks Reservoir Ex Acreage	Forks Reservoir Ex Acreage 850 Canal	Lower St. Mary Lake 850 Canal	Lower St. Mary Lake	Lower St. Mary Lake Capped Credit	Lower St. Mary Lake Capped Credit 850 Canal	Miners Coulee	Miners Coulee 850 Canal	Miners Coulee Capped Credit	Miners Coulee Capped Credit 850 Canal	Modified Annual Balancing	Modified Annual Balancing 850 Canal	No Cap Credit	No Cap Credit 850 Canal	Upper and Lower St. Mary Lake	Upper and Lower St. Mary Lake 850 Canal
	RiverWare	RiverWare	RiverWare	RiverWare	RiverWare	RiverWare	RiverWare	RiverWare	RiverWare	RiverWare	RiverWare	RiverWare	RiverWare	RiverWare	RiverWare	RiverWare	RiverWare	RiverWare	RiverWare	RiverWare	RiverWare
U.S. Entitlement Receipt: St. Mary	13	25	33	0	13	0	13	26	13	28	33	0	13	25	33	25	33	26	33	29	33
CA Entitlement Receipt: St. Mary	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-7	-10	0	0	0	0
U.S. Entitlement Receipt: Milk	0	0	0	0	0	-3	-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CA Entitlement Receipt: Milk	0	13	13	13	13	33	33	0	0	13	13	13	13	13	13	13	13	13	13	0	0

Figure 32. Performance indicator results for receipt of entitlements for the late-century period (2068 – 2100)

These results show that under the average range of possible climate futures, the structural, non-structural, and combined scenarios considered with RiverWare are consistent with the measured historical period. In other words, the Study's results are likely to hold true for the middle range of climate scenarios considered in the Study. More work is required to examine the robustness of the study results under more extreme possible climate futures.

5.4 Other Performance Indicators of Final Scenario Results

Several figures are shown in the following subsections to demonstrate how the performance indicators were used to analyze the modelled data for the Study. The PIs represent comparisons to the base case, where operating procedures in the model are as close as possible to the actual operating procedures that took place over the period 1982-2014. In the images of the PIs from the data visualization tool, the darker green boxes (with larger positive values) indicate improvements in entitlement compared to the base case, and darker brown boxes (with larger negative values) indicate negative impacts to entitlement compared to the base case. The PIs displayed in the subsequent figures describe the changes in the amount of entitlement received by each country due to each modelled scenario.

5.4.1 Irrigation Availability Considerations

The PI for the United States Milk River irrigation users was based on the modelled change in inflow to Fresno Reservoir from May through August. When the change in May–August inflow was greater than 20,000 acre-feet (24,700 dam³), the year was classified as showing improvement from the base case. This 20,000 acre-feet threshold is approximately 11 percent of the average May-August Fresno inflow for the base case scenario across the modelled water years (1982–2014). If the decrease in Fresno inflow between the scenario and base case was greater than 20,000 acre-feet, the year was then classified as having a reduction in scenario performance. An increase or decrease of less than 20,000 acre-feet was classified as “no change.”

The performance indicator for each individual month for the United States Milk River was based on a change of 5,000 acre-feet (6,200 dam³). 5,000 acre-feet is approximately 11 percent of average May inflow, 9 percent of average June inflow, 12 percent of average July inflow, and 15 percent of average August inflow. When the forecasted change in the total monthly inflow to Fresno Reservoir was greater than 5,000 acre-feet, the month was considered to show an improvement from base case. When the decrease in monthly total inflow to Fresno was greater than 5,000 acre-feet, the month was classified as having a reduction in performance.

The performance indicator for the Canadian Milk River irrigators was based on irrigation shortages. Irrigation shortage is the difference between irrigation demands and the flow that is diverted for irrigation. If the irrigation shortage of the scenario decreased compared to the shortage under the base case, then the month or year was considered an improvement of scenario performance. If the shortage increased under the scenario compared to the base case, then the performance of the scenario was classified as exhibiting a decrease in scenario performance.

The scenario performance indicator for the Canadian St. Mary River users was based on the change in flow across the International Boundary from May through August. 30,000 acre-feet (37,000 dam³) is approximately 10 percent of the average May- August flow of the St. Mary River across the IB for the base case scenario across the modelled water years (1982–2014). When the change in May–August flow was greater than 30,000 acre-feet, the year was classified as an improvement from the base case. If the

decrease in flow across the IB between the scenario and base case was greater than 30,000 acre-feet, the year was then classified as showing a reduction in scenario performance.

The performance indicator for each individual month for the Canadian St. Mary River was based on a change of 7,500 acre-feet (9,300 dam³). 7,500 acre-feet is approximately 9 percent of average flow in May, 6 percent of average flow in June, 10 percent of average flow in July, and 25 percent of average flow in August. When the change in the total monthly flow across the IB was greater than 7,500 acre-feet, the month was considered to show an improvement from base case. When the decrease in monthly total flow across the international boundary was greater than 7,500 acre-feet, the month was classified as exhibiting a reduction in performance.

Figure 33 shows the degree of improvement offered by each of the different administrative and structural (storage or canal) scenarios on various irrigation users in the St. Mary and Milk Rivers Basin. With the implementation of administrative options and/or additional Canadian storage, irrigators on the Canadian Milk River are expected to be better able to access their entitlement of water.

	850 cfs Canal		Forks Reservoir		Forks Reservoir 850 Canal		Lower St Mary Lake 850 Canal		Lower St Mary Lake		Miners Coulee		Miners Coulee 850 Canal		Modified Annual Balancing		Modified Annual Balancing 850 Canal		No Cap Credit		No Cap Credit 850 Canal		Upper and Lower St Mary Lake		Upper and Lower St Mary Lake 850 Canal	
	RiverWare	WRMM	RiverWare	WRMM	RiverWare	WRMM	RiverWare	WRMM	RiverWare	WRMM	RiverWare	WRMM	RiverWare	WRMM	RiverWare	WRMM	RiverWare	WRMM	RiverWare	WRMM	RiverWare	WRMM	RiverWare	WRMM	RiverWare	WRMM
CA Irrigation: St. Mary (May-Aug)	-10	-9	0	0	-10	-7	-12	-11	0	0	0	0	-10	-9	-3	-3	-20	-22	0	-1	-14	-14	0	0	-12	-12
CA Irrigation: St. Mary (May)	-1	-1	0	0	-1	-1	-5	-4	-2	-3	0	0	-1	-1	-15	-18	-22	-20	-10	-12	-20	-17	-2	-2	-5	-4
CA Irrigation: St. Mary (June)	-17	-15	0	3	-17	-12	-19	-18	-5	-5	0	1	-17	-14	11	10	-22	-16	12	10	-18	-14	-5	-6	-19	-18
CA Irrigation: St. Mary (July)	-12	-13	0	0	-12	-13	-12	-13	1	1	0	0	-12	-13	-11	-7	-16	-17	-8	-5	-14	-16	1	1	-12	-13
CA Irrigation: St. Mary (Aug)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-22	-11	-12	-12	-18	-9	-10	-10	0	0	0	0
CA Irrigation: Milk (May-Aug)	0	0	33	30	33	30	0	0	0	0	33	30	33	30	29	30	29	30	29	30	29	30	0	0	0	0
CA Irrigation: Milk (May)	0	0	17	7	17	7	0	0	0	0	13	7	13	7	11	7	11	7	11	7	11	7	0	0	0	0
CA Irrigation: Milk (June)	0	0	7	11	7	11	0	0	0	0	21	11	21	11	17	11	17	11	17	11	17	11	0	0	0	0
CA Irrigation: Milk (July)	0	0	7	29	7	29	0	0	0	0	19	29	19	29	29	29	29	29	29	29	29	29	0	0	0	0
CA Irrigation: Milk (Aug)	0	0	29	29	29	29	0	0	0	0	6	29	6	29	29	29	29	29	29	29	29	29	0	0	0	0
U.S. Irrigation: Fresno (May-Aug)	19	20	-1	0	16	19	20	21	0	0	0	0	19	22	2	0	26	26	1	0	21	23	0	0	20	22
U.S. Irrigation: Fresno (May)	23	16	-5	-2	17	10	27	21	3	5	0	0	22	16	9	9	28	24	9	10	31	28	6	7	29	21
U.S. Irrigation: Fresno (June)	32	32	-4	-3	29	31	32	32	0	0	0	0	32	32	0	1	33	32	0	1	32	31	0	0	32	32
U.S. Irrigation: Fresno (July)	23	25	-1	-1	23	24	24	24	0	0	0	0	23	26	1	1	25	26	0	0	25	26	0	0	24	25
U.S. Irrigation: Fresno (Aug)	1	1	0	-1	1	4	1	1	2	0	0	0	1	1	4	3	7	11	3	1	4	5	3	1	1	3

Figure 33. Performance indicators used to evaluate scenario outcomes for Canadian Milk River and St. Mary River users

The figure shows a comparison of scenario results to the base case using changes in monthly performance indicators, positive (+) changes in shades of green and negative (-) changes in shades of brown. Milk River irrigators' performance is based on irrigation shortages, defined as the difference between demand and diverted flow. St. Mary River users' performance is assessed by changes in May-August flow across the International Boundary. A change exceeding $\pm 30,000$ acre-feet (about 10 percent of the average May-August base case flow for 1982-2014) is the threshold for improved or reduced performance, respectively.

5.4.2 Aquatic Ecosystem Considerations

The PI on Bull Trout Population Growth rates is a summary of the categorical changes in growth rate that the scenario caused, compared to the base case growth rates. Table 9 shows, for each month evaluated (July-September), the number of modelled years that the bull trout population growth rate

category was considered declining, stable, or growing. To evaluate the scenarios, the population growth rate category, which was determined based on flow rate, was compared to the base case category. When the growth rate category changed from “Growth” to “Stable” or “Decline” or from “Stable” to “Decline”, the month was labeled as a reduction in scenario performance. When the growth rate category changed from “Decline” to “Stable” or “Growth” or from “Stable” to “Growth”, then the month was labeled as showing an improvement in scenario performance. Figure 34 summarizes the results, showing that most scenarios exhibited neutral or slightly negative performance.

Table 9. Count of the number of years in a Bull Trout Population Growth Rate category for the base case

Month	Decline	Stable	Growth
July	20	2	12
August	25	7	2
September	22	3	9

Figure 34. Performance indicator results for bull trout population growth rate

	850 cfs Canal		Forks Reservoir		Forks Reservoir 850 Canal		Lower St. Mary Lake 850 Canal		Lower St. Mary Lake		Miners Coulee		Miners Coulee 850 Canal		Modified Annual Balancing		Modified Annual Balancing 850 Canal		No Cap Credit		No Cap Credit 850 Canal		Upper and Lower St. Mary Lake		Upper and Lower St. Mary Lake 850 Canal	
	RiverWare	WRM	RiverWare	WRM	RiverWare	WRM	RiverWare	WRM	RiverWare	WRM	RiverWare	WRM	RiverWare	WRM	RiverWare	WRM	RiverWare	WRM	RiverWare	WRM	RiverWare	WRM	RiverWare	WRM	RiverWare	WRM
Bull Trout Growth Rate (July)	-4	-5	0	0	-4	-5	-4	-5	1	0	0	0	-4	-5	0	-3	-8	-5	0	-1	-8	-5	1	0	-5	-5
Bull Trout Growth Rate (Aug.)	0	-1	0	0	0	-1	0	-1	0	0	0	0	0	-1	-18	-13	-12	-12	-15	-10	-10	-11	0	0	0	-1
Bull Trout Growth Rate (Sept)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-13	-11	-7	-9	-11	-10	-6	-8	0	0	0	0

5.5 Additional Model Runs to Consider

Toward the end of the study, and after recommendations were being considered, it was recommended that the Study Board consider the proposed Canadian Forks Reservoir. This additional option would involve operating the reservoir as a shared storage for both the United States and Canada, providing potential economic benefits to both countries. The proposed reservoir was originally considered by the Infrastructure TWG, but was a lower priority for modelling. A modification to the Forks Reservoir scenario was subsequently considered, aiming to store water for both the United States and Canada. Sharing the storage could enhance resilience and provide additional storage capacity for the United States’ Milk River entitlement. However, the complexities of managing this shared storage, such as prioritizing storage of water from one country over another or accounting for multi-year withdrawals or evaporation, exceeded the Study’s limited modelling capacity, preventing it from being modelled. The Study Board recognizes that a binational storage approach could allow episodic surpluses to be captured and allocated according to agreed rules, maximizing the value of rare high-flow events. Shared storage could also support flexible, adaptive operations, enabling both countries to respond to hydrologic extremes, optimize reservoir releases (including Nelson Reservoir), and improve drought resilience.

- 1 without requiring consistently high annual flows. This scenario could be modelled and considered in
- 2 future discussions around the potential investment in Canadian Milk River infrastructure, and specifically
- 3 the Forks Reservoir. The benefits to Canadian Milk River irrigators would not change, but there could be
- 4 added benefit to the US Milk River project that need to be quantified and examined.

- 5 Due to the fact that the Study team ran only one potential future hydroclimate scenario through one
- 6 water management model, future work could also consider looking at a broader range of uncertainty in
- 7 the future hydroclimate. Exploring the most promising structural and non-structural scenarios under
- 8 different potential future streamflow regimes would further inform the potential resilience of these
- 9 scenarios.

6 STUDY RECOMMENDATIONS

As the Technical Working Groups and Options Formulation and Evaluation Group began completing their work and providing preliminary findings, the Study Board began considering recommendations based on four and a half years of gaining a better understanding of how water is apportioned in the St. Mary and Milk Rivers and considering how that could be improved. This new understanding led the Board to consider two classes or kinds of recommendations: (1) more general recommendations about how the AOs and the IJC could more effectively work with local citizens and government entities in these watersheds and (2) specific recommendations on how the AOs' administrative procedures or the infrastructure in these watersheds could be changed to help each country better access their share of the water.

General recommendations addressed topics like:

- Water management modelling
- Data analysis and evaluation
- Infrastructure Investments
- Engagement of Advisory Groups following the completion of the Study

More specific recommendations focused on a significant change in administrative procedures as well as a list of infrastructure changes that seem most likely to improve access to entitlements for one country or the other in some circumstances. The administrative and infrastructure changes that are recommended included:

- Modified Annual Balancing Administrative Option
- 850 ft³/s Canal
- Control structures on Upper and Lower St. Mary Lakes
- Long-term storage development on the Milk River

6.1 General Recommendations

Starting in the fall of 2025, while awaiting the final modelling results to evaluate different administrative and infrastructure options, the Study Board began developing a group of general recommendations to the IJC and AOs based on our observations and our vision for how water could be apportioned in these watersheds in the future. Through its engagement activities, the Board gained a broader understanding of stakeholder perspectives and watershed governance issues, allowing it to develop general recommendations focused on improving collaboration, transparency, and decision-making in the apportionment process. The process to develop these recommendations was simple and straightforward and the Board had no difficulty quickly reaching consensus on the need for four recommendations described in the following subsections.

The Board discussed potential recommendations through a series of regular weekly meetings. Initial recommendation concepts were developed and drafted by a subset of the study team and subsequently circulated to the full Board for review. Draft recommendations were refined through an iterative process of editing and discussion during weekly meetings, allowing Board members to provide input and build consensus. Recommendations received tentative approval during these regular meetings before being formally deliberated upon and approved by the Board at an in-person meeting held in Calgary in February 2026.

6.1.1 Water Management Modelling

Findings

The Study Board invested considerable resources updating two proprietary, legacy water management models developed by partner agencies in each country for use in this study. The Board considered other potential water management modelling software and was unable to identify an appropriate open-source and cost-effective alternative. After comparing results from these two primarily independently developed models, the board recognized that the use of two models greatly enhanced understanding of water apportionment in these watersheds and increased confidence in the models' results.

Recommendation

The Study Board recommends the IJC and Accredited Officers maintain the ability to use one or more of these water management models to evaluate new scenarios that might be developed in the coming years.

6.1.2 Data Analysis and Visualization

Findings

Given the complexity and amount of data produced by the two water management models, the development of a data analysis and visualization tool was required so the Study Board, as well as the members of Advisory Groups and the Government Forum, could view the data and compare different scenarios that were modelled, increasing transparency of the work conducted throughout the study.

Recommendation

We recommend the IJC consider this type of data analysis and visualization application within the basin and noted that such an approach could be effective for use across other boards.

6.1.3 Infrastructure Investments

Findings

The IJC should be aware that, at times, both countries are affected by changes/improvements in infrastructure by the upstream country. Also, the perception or reality that the downstream country can benefit from the upstream infrastructure changes, without a financial contribution, can potentially harm the sharing of the water in these watersheds, and the willingness for jurisdictions to work together to make the most effective and efficient use of water in these watersheds. The Board consistently heard participants identifying infrastructure as a key factor in improving water management in the St. Mary and Milk River basins. Stakeholders emphasized the need to repair, upgrade, and replace aging diversion and conveyance systems to improve reliability, support water users, increase resilience to changing conditions, and sustain long-term watershed health and cross-border water-sharing arrangements. Therefore, when infrastructure options are being evaluated, there are benefits and costs to both countries.

Recommendations

We recommend that the IJC and governments ensure that, when changes/improvement in infrastructure and administrative options are being considered, governments evaluate the benefits and the costs to each country.

We also recommend that governments explore ways that ongoing maintenance costs as well as capital improvement or initial building costs can be shared, when reasonable, should both countries benefit from existing, upgraded, or new infrastructure.

6.1.4 Integrating Aquatic Ecosystem Considerations

Findings

The Aquatic Ecosystems Technical Working Group identified aquatic species that are threatened, endangered, extirpated or are of special concern, including those listed under the Canadian Species at Risk Act (SARA) and the US Endangered Species Act (ESA). Performance indicators were developed for bull trout response to streamflow in the St. Mary system and were used to conduct a preliminary assessment of how modelled apportionment scenarios could potentially affect population-level responses. Knowledge gaps and the lack of available data to inform the development and application of other relevant environmental flow indicators were also identified. Over the course of the Study, input from the Public Advisory Group and the Indigenous Advisory Group provided additional perspectives on knowledge gaps and concerns regarding future water apportionment decisions and their potential effects on the ecological integrity and aquatic health of the basins.

The Board recognizes that under the IJC's 1921 Order, the Accredited Officers' (AOs') mandate is strictly water apportionment, and the following recommended efforts would be undertaken by relevant parties outside of or in addition to the AOs' current responsibilities.

Recommendations

The Study Board recommends that:

The Study Board recommends that the AOs, in cooperation with relevant agencies, Indigenous Nations/Tribes, stakeholders, and other interested parties, investigate opportunities to improve understanding of the impacts of water apportionment decisions on aquatic ecosystem considerations within the St. Mary and Milk River basins. Such efforts should build upon existing scientific studies, monitoring programs, Indigenous Knowledge, and local expertise to better understand the relationship between water apportionment, flow regimes, and ecosystem health.

The Accredited Officers should consider whether additional information, monitoring, or analytical approaches could support the future consideration of aquatic ecosystem health within the framework of the Boundary Waters Treaty, the 1921 Order, and existing water accounting and apportionment procedures. This may include evaluating ecological flow relationships, seasonal flow requirements, and indicators related to species and habitats of concern where such information is available and relevant to water management decisions.

The Study Board further recommends that the development of ecological flow relationships continue to advance and mature through existing programs and initiatives to identify critical thresholds, seasonal needs, and management considerations for species and habitats of concern. This may include the further development of performance indicators for aquatic species and riparian communities (e.g., cottonwood) that could improve understanding of the potential ecological implications of future water management and apportionment decisions.

This approach would provide additional information to support future decision-making while recognizing the Accredited Officers' primary responsibility for water apportionment under the Boundary Waters Treaty and the 1921 Order.

6.1.5 Engagement of Advisory Groups Following the Completion of the Study

Findings

As part of the Study's directive, the IJC, in cooperation with the Study Board, established three advisory groups (Indigenous Advisory Group, Public Advisory Group, and Government Forum) that included members of Indigenous Nations, irrigators, stakeholders, and resource managers from local, State, Indigenous, Provincial and Federal governments. Members of these advisory groups have contributed valuable perspectives from the basin.

Engaging Indigenous Peoples, governments, and the public through these Advisory Groups has positively impacted the Study outcomes. Most of the engineers and scientists in the TWGs do not depend upon water resources in the basin and their interpretation of Study outcomes benefits from shared information from the Advisory Group members with experiential and historical knowledge in the basin.

Insights offered during Advisory Group meetings were tracked and ultimately helped the Study Board make final recommendations. Among the most successful engagement activities for advisory groups were in-person meetings held in the United States and Canada. Meetings built an avenue for connection and sharing amongst people in the basin and the Study Board and resulted in greater understanding of what it means to be “upstream and downstream.” For example, a conversation between irrigators in 2023 during an unusual hydro-climatic year in the basin (e.g. persistent wet conditions in the United States compared with drier conditions in Canada) resulted in an additional sharing of water from the United States to Canada. During this period, US irrigators encouraged the Accredited Officers to allow Canadian Milk River irrigators to continue pumping after their share of Milk River flows fell below their average use, benefiting Canadian irrigators without harming US irrigators who needed no additional Milk River water for the season. As a result, the Study has generated positive momentum regarding understanding of shared waters of the St. Mary and Milk River basin, and the collaboration must continue beyond the life of the Study.

Recommendation

The Study Board recommends that the Accredited Officers, in consultations with IJC and governments at all levels, continue engagement, involvement and education of basin communities (Indigenous Nations, irrigators, Federal, State, Provincial, and local resource managers) in the work of water apportionment.

6.2 Administrative and Infrastructure Recommendations

The Study Board considered a number of changes in administrative procedures and infrastructure that could improve the ability of each country to access its full entitlement of St. Mary and Milk River natural flows. Examination of the modelled effects of a wide variety of administrative and infrastructure options, individually and in combination, indicated that as each country came closer to receiving its full entitlement. All options were evaluated using all performance indicators, with a primary focus on each country’s ability to access its full entitlement and availability of water to meet irrigation demands between May and August.

The Study Board recognized that infrastructure investment and the allocation of costs for water resources infrastructure are a significant issue on both sides of the international border. Infrastructure costs and allocation remain the responsibility of water users and the local, State/Provincial, Indigenous, and Federal governments in Canada and the United States. The allocation of costs and political realities of potential infrastructure options were not considered in deliberations toward final recommendations.

All model runs were constrained by the Boundary Waters Treaty, the IJC’s 1921 Order to the AOs, and local water rights. Limited environmental effects of each option were also considered, along with potential advantages or disadvantages under future potential climate differences.

6.2.1 Modified Annual Balancing Administrative Option

Findings

The three viable administrative options (Capped Credits, No-Cap Credits, and Modified Annual Balancing) performed comparably in improving each country's access to its entitlement. All three administrative options allow Canadian Milk River users access to up to 4,000 acre-feet (4,900 dam³) of US St. Mary water flowing in the Milk River canal when the natural flow of the Milk River is insufficient to meet current Canadian Milk River irrigation demand. The Modified Annual Balancing administrative option is simpler to implement compared to the other two, while providing greater administrative flexibility and resilience in the system.

Under the existing 600 ft³/s (17 m³/s) canal capacity: On the Milk River, modelling results indicate that the Modified Annual Balancing option provides a modest but meaningful increase to US receipt of St. Mary River entitlement while enabling Canadian Milk River irrigators to reliably meet their existing irrigation demand. On the St. Mary River, implementation of the Modified Annual Balancing administrative option would ensure that Canadian St. Mary River irrigators can continue to access their full entitlement in most years and would incrementally increase US access to its entitlement.

The ability of the United States to receive its full entitlement requires the 850 ft³/s canal in addition to implementing the Modified Annual Balancing administrative option.

Recommendation

It is recommended that the Modified Annual Balancing administrative option be implemented as soon as administratively practical.

6.2.2 850 ft³/s Canal

Findings

Rehabilitation of the US St. Mary Canal to its original engineered design capacity of 850 ft³/s (24.1 m³/s) would have by far the greatest positive effect on the ability of the United States to more fully access its entitlement of St. Mary water by providing the most additional water to Fresno Reservoir during irrigation season compared to any other changes considered. In wetter years (median or greater annual natural flow), model results indicated an estimated additional 35,000-60,000 acre-feet (43,000 – 74,000 dam³) of St. Mary River water could be delivered into the Milk River system for use by the US Milk River Project or potentially by individual Canadian Milk River irrigators in conjunction with changes in administrative procedures.

Recommendation

The Study Board recommends that governments prioritize the rehabilitation of the US St. Mary Canal to its original design capacity of 850 ft³/s.

6.2.3 Control Structures on Upper and Lower St. Mary Lakes

Findings

The Board investigated the value of adding control structures on Upper and Lower St. Mary Lakes. This would provide approximately 16,640 acre-feet (20,500 dam³) of additional active storage. This measure would enhance basin-wide operational flexibility, and drought and environmental resilience. Under a 600 ft³/s canal capacity, the incremental benefit of this added storage is expected to be marginal, as conveyance capacity, rather than storage, is limiting. Under an 850 ft³/s canal capacity, the additional storage could meaningfully improve water availability for United States irrigators during drier periods.

Recommendation

The Study Board recommends that control structures be installed on Upper and Lower St. Mary Lakes and therefore that feasibility analyses be conducted on the addition of these control structures, including analysis of alternatives.

6.2.4 Long-Term Storage Development on the Milk River

Findings

On the Canadian portion of the Milk River basin, Canada's ability to access its full entitlement is storage dependent. Without additional storage, entitlement access remains constrained by hydrologic variability and operational limitations. The Board evaluated two different Canadian Milk River storage options: on-channel (Forks Reservoir) and off-channel (Miners Coulee Reservoir).

As noted earlier, the Modified Annual Balancing administrative option allows Canadian Milk River receipts to fully support current irrigation demand, adding limited resiliency since it allows access to available water on the Milk River to meet Canada's minimum irrigation demand, but adds no storage. Miners Coulee Reservoir could be used to provide increased interannual resiliency as well as a modest improvement to entitlement receipt. Forks Reservoir would allow Canadian Milk River receipts to approach full entitlement, allowing increased use, and would contribute additional resiliency to the Milk River basin.

Recommendation

For Canada to achieve increased interannual resiliency on the Milk River, construction of either Miners Coulee or Forks Reservoirs is required.

For Canada to access its full entitlement on the Milk River, construction of the Forks Reservoir is required, without the need for Miners Coulee Reservoir.

6.3 Anticipated Outcome if Recommendations are Implemented

Option 1: Canadian Milk River Storage not considered

Simulation of the implementation of all of the Study Board's recommendations, except for Milk River storage, indicates that the United States would be able to access nearly its full entitlement in many years, current irrigation demands in the Milk River basin in Canada would be met, and Canadian St. Mary River receipts would still exceed Canada's entitlement except for a rare year when Canada would receive very close to its full entitlement on the St. Mary (Table 10).

Table 10. Canadian and US annual water entitlement receipts (in percent) for the St. Mary and Milk Rivers using all administrative and structural recommendations except adding Milk River storage

	Simulated Annual Entitlement Received (%)			Difference in Current and Simulated Annual Entitlement Received (%)		
	All years	Driest 50% of years	Driest 25% of years	All years	Driest 50% of years	Driest 25% of years
Canada – St. Mary	104	100	100	-13	-8	-8
US – St. Mary	95	100	100	+20	+13	+12
Canada – Milk	13	21	23	+4	+8	+9
US - Milk	146	141	143	-4	-2	-5

Simulation of the implementation of all the Board's recommendations, except for Milk River storage, indicates that for the model period, the United States would be able to access on average an additional approximately 50,000 ac-ft (62,000 dam³) of its St. Mary entitlement and Canada would be able to access on average an additional approximately 2,000 ac-ft (2,500 dam³) of its Milk River entitlement (Table 11). While the increased entitlement accessed by Canada sounds small, it results in a secure water supply to meet current irrigation demand in even the driest years.

Table 11. Canadian and US annual water entitlement receipts for the St. Mary and Milk Rivers if all recommendations except adding Milk River storage are implemented

	Simulated Annual Entitlement Received (1,000 ac-ft)			Difference in Current and Simulated Annual Entitlement Received (1,000 ac-ft)		
	All years	Driest 50% of years	Driest 25% of years	All years	Driest 50% of years	Driest 25% of years
Canada – St. Mary	386	318	289	-50	-26	-22
US – St. Mary	242	208	185	+50	+26	+22
Canada – Milk	5	5	5	+2	+2	+2
US - Milk	98	58	53	-3	-1	-2

Simulation of implementation of all the Board's recommendations, except for Milk River storage, indicates that both countries would be able to access their full St. Mary entitlements in most years, with Canada accessing a little more in wetter years. Without building Milk River storage, Canada will be unable to access its full Milk River entitlement, although implementation of the Modified Annual Balancing Administrative Option would provide a guaranteed water supply every year to support current irrigation demand in the Milk River basin in Canada.

Option 2: Including Canadian Milk River Storage

Simulation of implementation of all the Board's recommendations, including Milk River storage, indicates that the addition of Forks Reservoir and increased Canadian irrigation consumptive use from the Milk River would be required for Canada to fully access its entitlement on average for all 33 years in the model period (Table 12).

Table 12. Canadian and US annual water entitlement receipts in percent for the St. Mary and Milk Rivers if all recommendations are implemented, including adding Forks Reservoir for Milk River storage and increased Canadian Milk River irrigation demand

	Simulated Annual Entitlement Received (%)			Difference in Current and Simulated Annual Entitlement Received (%)		
	All years	Driest 50% of years	Driest 25% of years	All years	Driest 50% of years	Driest 25% of years
Canada – St. Mary	103	100	100	-14*	-8*	-7*
US – St. Mary	95	100	100	20	13	11
Canada – Milk	100	100	100	92	85	87
US - Milk	100	100	100	-51*	-46*	-49*

**Note: the decrease in annual entitlement received is based on the increased access of the upstream country to its full entitlement.*

When modelling the addition of Forks Reservoir and increased Canadian irrigation demand for the 33-year model period, Canadian Milk River annual receipts were 36,400 ac-ft (44,900 dam³) on average for

all years, 21,800 ac-ft (26,900 dam³) on average for the driest 17 years, and 21,200 ac-ft (26,200 dam³) on average for the driest 9 years.

6.4 Economic impact of implementation of recommendations

Economic studies performed for the Socio-Economic Analysis TWG indicated the value of water varied widely across the basins, from a maximum of CDN\$3,292/ac-ft in the St. Mary basin in Canada, to CDN\$998/ac-ft in the Milk River basin in Canada, to USD\$228/ac-ft in the Milk River basin in the United States. These dramatic differences in the value of water are driven by a number of factors, including geology and soils, greater investment in irrigation infrastructure and the production of higher value crops. This greater investment is in turn a direct result of the greater reliability and availability of water during the irrigation season in the St. Mary watershed compared to the Milk River watershed.

Modelling indicates that implementation of the Study Board's recommendations, except added Milk River storage would result in the changes in entitlement receipts on the St. Mary and Milk Rivers and associated economic benefits or losses shown in Table 13.

Table 13. Changes in Canadian and US annual water entitlement receipts for the St. Mary and Milk Rivers and associated economic loss (-) or benefit (+), if all recommendations except adding Milk River storage are implemented.

Country – Basin	Simulated Change in Annual Entitlement Receipt (+ or -, ac-ft)	Estimated Annual Economic Loss (-) or Benefit (+)
Canada – St. Mary River	-22,000 to -50,000 ac-ft	-CDN\$72 to -CDN\$165 million
Canada – Milk River	+2,000 ac-ft	+CDN\$2 million
US – St. Mary River	+22,000 to +50,000 ac-ft	+USD\$5 to +USD\$11 million
US – Milk River	-2,000 ac-ft	-USD\$0.5 million

Note the different currencies used to report the benefits and losses. As expected, because the value of irrigation water is significantly greater in the St. Mary basin in Canada, loss of water in Canada had a greater negative economic effect than the positive economic benefit to the United States of the added water.

Modelling indicates that implementation of all the Study Board's recommendations, including the addition of Canadian Milk River storage in Forks Reservoir and increased Canadian irrigation demand, would result in the changes in entitlement receipts in the Milk River basin and associated benefits or losses shown in Table 14.

Table 14. Changes in Canadian and US annual water entitlement receipts for the Milk River and associated economic loss (-) or benefit (+), if all recommendations are implemented, including adding Forks Reservoir for Milk River storage and increased

Country – Basin	Simulated Change in Annual Entitlement Receipt (+ or -, ac-ft)	Estimated Annual Economic Loss (-) or benefit (+)
Canada – Milk River	+18,000 to +34,000 ac-ft	+CDN\$19 million to +CDN\$33 million
US – Milk River	-18,000 to -34,000 ac-ft	-USD\$4 million to -USD\$8 million

The Study Board recognizes this reporting of the potential losses and benefits of receiving more or less water is simplistic, but also recognizes that a detailed analysis of the direct and indirect, short-term and long-term benefits and losses is a study into itself. This reporting is intended only to offer the reader a general idea of the potential economic effect of implementation of the administrative and infrastructure changes the Study Board is recommending. We would highlight for the reader that the initial as well as ongoing operation and maintenance costs of infrastructure changes are not included in this reporting.

The Directive to the Board from the IJC was to examine options for increasing each country's receipt of their water entitlement and to report on the economic effect of changes in the receipts. Water has substantial value in both countries, so changes in receipts are not without both positive and negative effects. Unfortunately, options recommended to improve receipts and bring them more in accordance with the Treaty and the Order of 1921 have a greater negative economic impact on Canadian water users than the positive effect on those in the United States due to different irrigation and cropping practices. The Study noted these differences as described here, but did not consider them when developing recommendations because neither the Treaty nor the IJC's Directive suggest water should be apportioned based on greatest economic benefit, but instead on equal shares, after taking prior appropriation into account.

7 SUMMARY AND PATH FORWARD

The International St. Mary and Milk Rivers Study was undertaken in response to long-standing challenges associated with the apportionment and use of shared water resources between Canada and the United States. Based on the International Joint Commission's (IJC) 2021 Directive, the Study evaluated whether changes to water management procedures, infrastructure, or a combination of both could improve each country's ability to receive and utilize its entitled share of water under the 1909 Boundary Waters Treaty and the 1921 IJC Order. Over a five-year period, the Study brought together technical experts, government agencies, Indigenous Nations, stakeholders, and members of the public to assess the future of water management within the St. Mary and Milk River basins.

The Study was motivated by a challenge that has persisted for decades: although the apportionment framework has generally functioned as intended, neither country has consistently been able to fully access its entitlements. The St. Mary River basin benefits from a relatively reliable snowmelt-driven water supply originating in the Rocky Mountains, while the Milk River basin experiences much greater variability and is strongly influenced by seasonal runoff and precipitation. Historical analyses demonstrated that infrastructure constraints, operational limitations, and the timing of water availability have often prevented the United States from fully accessing its St. Mary River entitlement and Canada from fully accessing its Milk River entitlement. As outlined in the directive, the Study examined system resilience for the future. Results from climate and hydrologic modelling indicate continued warming across both basins, reductions in snowpack, altered runoff timing, increased evapotranspiration, and a greater risk of drought, particularly within the Milk River basin. While uncertainty remains regarding future precipitation patterns, there is broad agreement that water managers will need greater operational flexibility and improved infrastructure to address increasing variability in water supply. The findings underscore the importance of adaptive management approaches that remain effective under a range of future climate conditions.

To evaluate potential solutions, the Study examined a broad range of structural and administrative options. Structural options focused primarily on increasing conveyance and storage capacity within the basin, while administrative options explored modifications to the procedures used by the Accredited Officers to account for and apportion water. Advanced hydrologic and water management models were used to test these options individually and in combination. Performance indicators were then developed to assess impacts on entitlement receipt, irrigation reliability, and aquatic ecosystem considerations. A key conclusion of the Study is that no single option can fully resolve all apportionment challenges. Instead, the modelling consistently demonstrated that the most effective outcomes are achieved through a combination of administrative flexibility and targeted infrastructure investments. Among the administrative options evaluated, the Modified Annual Balancing approach emerged as the preferred recommendation. This option produced benefits comparable to more complex credit-based systems while being simpler to implement and administer. The approach increases flexibility by accounting for surpluses and deficits over a longer balancing period and allows water users to better match water use with the timing of supply, while remaining consistent with the requirements of the Treaty and Order.

The Study also identified several infrastructure improvements that provide significant opportunities to improve access to entitled waters. Rehabilitation of the United States St. Mary Canal to its original design capacity of 850 cubic feet per second was found to offer the single largest improvement to the United States' ability to access its St. Mary River entitlement. Increasing the canal capacity would enhance conveyance of water into the Milk River system and improve water availability for downstream irrigation and water use. Additional storage on the Upper and Lower St. Mary Lakes was also shown to improve operational flexibility and drought resilience, especially when combined with the increased canal capacity. For Canada, the Study clearly demonstrated that long-term storage development on the Milk River is essential if the country is to significantly improve access to its Milk River entitlement. Without additional storage, Canada's ability to capture and retain water during periods of high flow remains constrained. Of the options evaluated, the proposed Forks Reservoir provided the greatest receipt and offers the potential for Canada to approach full utilization of its Milk River entitlement while also increasing drought resilience and supporting future irrigation development. The Miners Coulee option provided more modest benefits but still increased operational reliability and water security.

The Study also highlighted the importance of considering environmental, social, and economic factors alongside water apportionment objectives. Input received throughout the engagement process emphasized the importance of protecting aquatic ecosystems, supporting agricultural communities, respecting Indigenous perspectives and interests, and ensuring long-term watershed sustainability. The Board concluded that future consideration of environmental flow needs, improved ecological monitoring, and continued engagement with Indigenous Nations and local communities will be important components of successful watershed management. Based on the collective findings of the technical analyses, modelling efforts, and engagement activities, the Study Board developed a set of recommendations intended to improve each country's ability to access entitled waters while maintaining the cooperative spirit of the Boundary Waters Treaty. These recommendations include implementation of a Modified Annual Balancing procedure, rehabilitation of the St. Mary Canal to 850 ft³/s capacity, further evaluation of control structures on Upper and Lower St. Mary Lakes, and development of long-term storage on the Canadian Milk River. In addition, the Board recommended continued investment in water management models, data visualization tools, environmental flow studies, and ongoing engagement with basin communities and governments. Together, these measures provide a practical and adaptive pathway toward improving water management in the basin under both current and future conditions.

Following completion of the Study, the process moves from recommendation to review and potential implementation. The Study Board will submit its recommendations to the International Joint Commission following the public review period. The IJC will then evaluate the recommendations and seek additional input from the Accredited Officers, who may engage provincial, state, federal, Indigenous, and other interested parties on matters related to implementation. The IJC will consider this information in developing its own recommendations to the Governments of Canada and the United States. Administrative recommendations, such as changes to apportionment procedures, could be addressed through future actions by the Accredited Officers and may be implemented relatively quickly if accepted. Structural recommendations, however, would proceed through domestic government processes that may include engineering studies, environmental assessments, funding decisions, regulatory approvals, and potential future IJC review where shared boundary waters are affected. In all cases, implementation decisions ultimately rest with the

1 responsible governments and agencies, while the IJC continues its role of providing independent oversight
2 and fostering cooperative management of these shared international waters.

3
4 In conclusion, the study, based on the IJC directive and the Board's Work Plan, successfully identified and
5 evaluated structural and non-structural options to improve each country's ability to receive and utilize its
6 water entitlement under the 1909 Boundary Waters Treaty and the 1921 Order. It developed and applied
7 hydrologic and water management models to assess administrative and infrastructure alternatives,
8 quantifying their effects on water entitlement receipt, operational flexibility, drought resilience, and water
9 management performance under current and future climate conditions. The modelling showed that no single
10 measure could resolve existing apportionment challenges, and a combination of measures, including
11 Modified Annual Balancing, St. Mary Canal rehabilitation, additional storage on the St. Mary Lakes, and long-
12 term storage development on the Canadian Milk River, was the most effective pathway to improve each
13 country's ability to access its entitled share of water. The Study met the Work Plan objective of evaluating the
14 broader implications of potential water management changes. Climate and hydrologic analyses confirmed
15 the importance of preparing for increased variability, altered runoff timing, and greater drought risk in the
16 basin. The Study also considered socio-economic and aquatic ecosystem factors and incorporated input from
17 Indigenous Nations, stakeholders, government agencies, agricultural interests, and basin communities.
18 Through this integrated approach, the Study provided science-based, stakeholder-informed
19 recommendations that address water management challenges while supporting the long-term sustainability
20 and cooperative management of the shared St. Mary and Milk River basins.

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Summary of Supplementary Documents

Throughout the Study, the various teams involved referred to many documents and produced many reports. For transparency, key supplementary documents have been compiled and are being released alongside the final study report. In addition to the St Mary and Milk Rivers Study Board Directive (SMMRSB Directive) and Study participants list, the supplementary documents related to the International St Mary and Milk Rivers Study (ISMMRSB) fall into four categories.

- The first category of documents were available to the ISMMRSB and Team that were not produced as part of the Study, but helped to inform the work of the Board. In cases where these documents are difficult to obtain, due to lack of internet availability or the authoring organization no longer existing, they are being made available as supplementary documents. Otherwise, they are listed as relevant references or as an annotated bibliography.
- The second category of supplementary documents are the “State of Knowledge (SoK) reports” that were developed by the Technical Working Groups (TWGs) at the beginning of the ISMMRS to articulate the foundational knowledge that the TWGs would be building upon.
- The third category of supplementary documents are Fact Sheets that were developed throughout the Study.
- The fourth, and final, category of supplementary documents are the reports that were developed by the ISMMRS’s TWGs as a part of the Study.

As of July 31, 2026, completing the list of supplementary documents is ongoing. The ISMMRS team is working to complete this list prior to submission of the Final Report to the International Joint Commission. If you notice any supplementary documents or key details that are missing, please reach out to the ISMMRS Study Managers (jvalder@usgs.gov, beau.hawkings@ec.gc.ca) for consideration of inclusion in the supplementary documents.