Adaptation Roadmap for Sustainable Water Management in the SSRB

Final Report: Climate Vulnerability and Sustainable Water Management in the South Saskatchewan River Basin Project

January 2016

Executive Summary

Alberta faces important water challenges including a growing economy, expanding population, and the increasing impact of this growth on the environment as weather and climate patterns shift. The recent experience of both floods and droughts has made climate variability a reality for residents in the South Saskatchewan River Basin (SSRB). Growth in southern Alberta in the face of fluctuating water supply underscores the need for adaptive management of this crucial resource. The global effort to mitigate climate change must be paralleled with an equal local effort on adaptation in Alberta to reduce the risks to water resources that will come as a result of climate change. An adaptive management approach aims to develop resilient and adaptive capacity to respond to a wide range of different situations by exploring what we can do with today's infrastructure and management and then look at what else could be done now and into the future. It also aims to raise social awareness of potential flood and drought risks in support of efforts to get appropriate water management arrangements in place now.

Watershed management and climate adaptation issues are complex and cannot be appropriately addressed by any single initiative or sector, making collaboration essential. Since 2010, a series of initiatives has brought together water managers and knowledgeable water users in each of the SSRB sub-basins to explore potential adaptation approaches. Building on these prior modelling collaborations, this project integrated the sub-basin models into one comprehensive model for the entire SSRB. A number of adaptation strategies were developed for each sub-basin and where data were available strategies were modelled and assessed using the South Saskatchewan River Operational Model (SSROM). The SSROM is a comprehensive, daily, mass balance river model that enabled the collaborative working groups to compare individual strategies and evaluate the net benefits of combinations of strategies across the full basin. Strategies were sorted into three Levels that reflect degrees of adaptation:

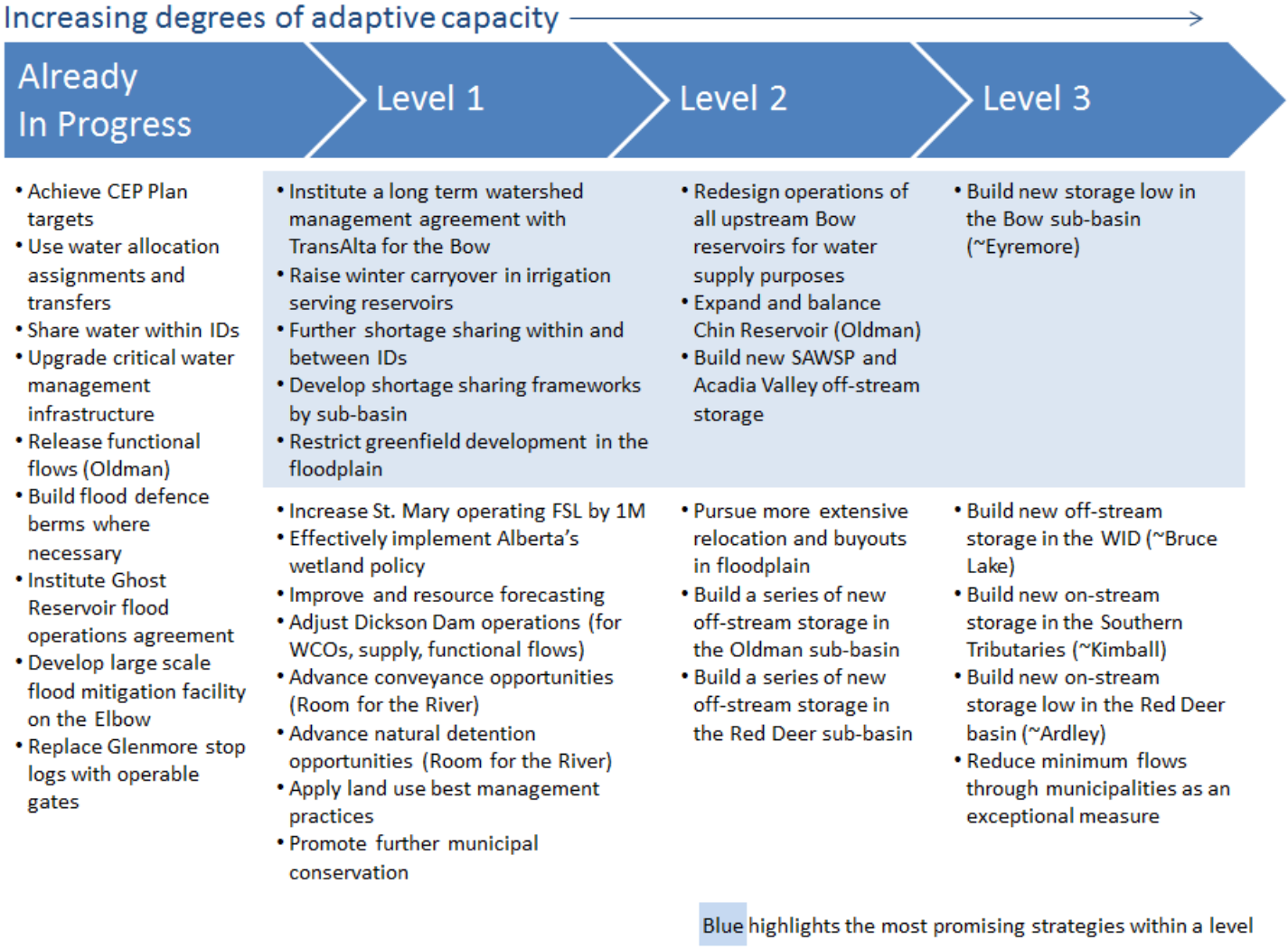
Level 1: Strategies that could be implemented now to adapt to current flows and conditions
Level 2: Strategies that would add another level of resilience to the basin
Level 3: Strategies that would make the basin more resilient to climatic changes

Based on the modelling results, some strategies within each Level were further categorized as "most promising." Firm criteria were not established or used to identify "most promising" strategies; however, considerations of relative simplicity, cost, impact and contribution to resilience were typically used to distinguish these from other strategies within and between Levels. The detailed results are presented in section 3 of this report.

This report puts forward the Adaptation Roadmap for Sustainable Water Management in the SSRB, based on previous and current collaborative efforts. The Roadmap recognizes the adaptation strategies already being implemented as well as the three Levels of adaptation strategies.

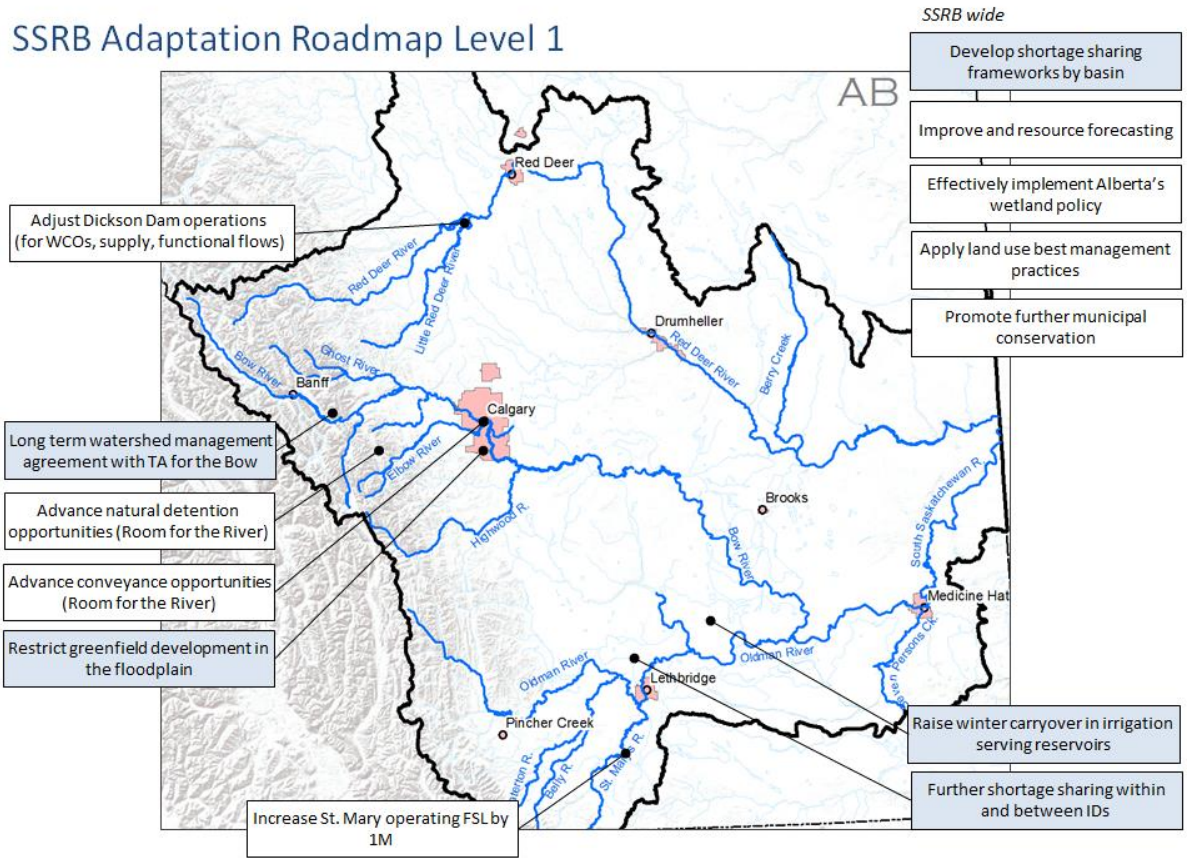
This executive summary briefly describes the benefits and implementation opportunities for each strategy in the Roadmap.

SSRB Adaptation Roadmap



Acronyms used in this figure are defined on page x.

The intention is not that all Level 1 strategies would be implemented immediately or all at once; rather, Level 1 identifies strategies that should be considered before moving to Level 2. Level 2 and 3 strategies could be further explored and implemented when the water supply and demand balance in the basin warrants it.



In the map above, strategies in the blue boxes were viewed as "most promising."

Institute a long-term, flexible and comprehensive water management agreement with TransAlta to use part of the existing reservoirs in the upper Bow to meet the environmental needs of a closed basin and provide extreme flood and drought mitigation, while still creating hydropower. This requires a negotiated agreement with TransAlta, fair compensation for lost revenue, a basin-driven governance model, and robust forecasting support.

Raise winter carryover in existing irrigation-serving reservoirs, starting with Travers Reservoir in the Bow River Irrigation District, to increase water supply security for irrigators while leaving more flow in the river. This can be piloted in 2016 through a Government of Alberta (GoA) approval for Travers, and then extended to other reservoirs with appropriate study of shoreline erosion impacts and dam safety.

Implement further forecast-based shortage sharing within and between irrigation districts, when conditions and forecasts suggest a dry year, to optimize crop planting and irrigation decisions across a region. These temporary assignments and transfers of water rights or licences are enabled through the existing *Water Act* and should continue to be used by the irrigation districts in coordination with GoA, forecasters and other agencies.

Develop basin-wide shortage-sharing and reallocation frameworks for each of the SSRB sub-basins to inform and enable severe drought mitigation before emergency measures need to be triggered. Championed by GoA, the strategy and frameworks could potentially be developed in two years.

Restrict new greenfield development in the floodplains and develop strict regulations against changing the nature of brownfield developments to reduce disturbance of the floodplain and reduce flood damage. This

requires policy leadership from Alberta Environment and Parks (AEP) with Alberta Municipal Affairs, as well as support and cooperation from municipalities in the floodplains.

Increase St. Mary Reservoir operating full supply level (FSL) by 1 metre to increase the usable storage capacity of an existing reservoir that is extremely well placed in the Oldman sub-basin, and which offers water supply benefits to irrigators and municipalities. This requires dam safety and shoreline studies prior to implementation, but could potentially be completed within 12 months.

Effectively implement Alberta's Wetland Policy to protect and restore the wetland functions of water retention, slowing release, and natural filtering. This depends on AEP's implementation plans, timelines, offset opportunities, and enforcement of the regulations.

Improve resourcing for and effectiveness of forecasting infrastructure, monitoring, modelling and communications systems and teams to anticipate, prepare for, and respond to extreme events across the SSRB in a consistent and coordinated manner.

Adjust Dickson Dam operations to consider downstream needs (retain the Red Deer River Water Conservation Objectives (WCOs), implement functional flows, meet some new demands) to maximize how the existing infrastructure can support the growth of the sub-basin before new infrastructure is required. These refinements could be adopted by the Dickson Dam operations team in AEP within three years.

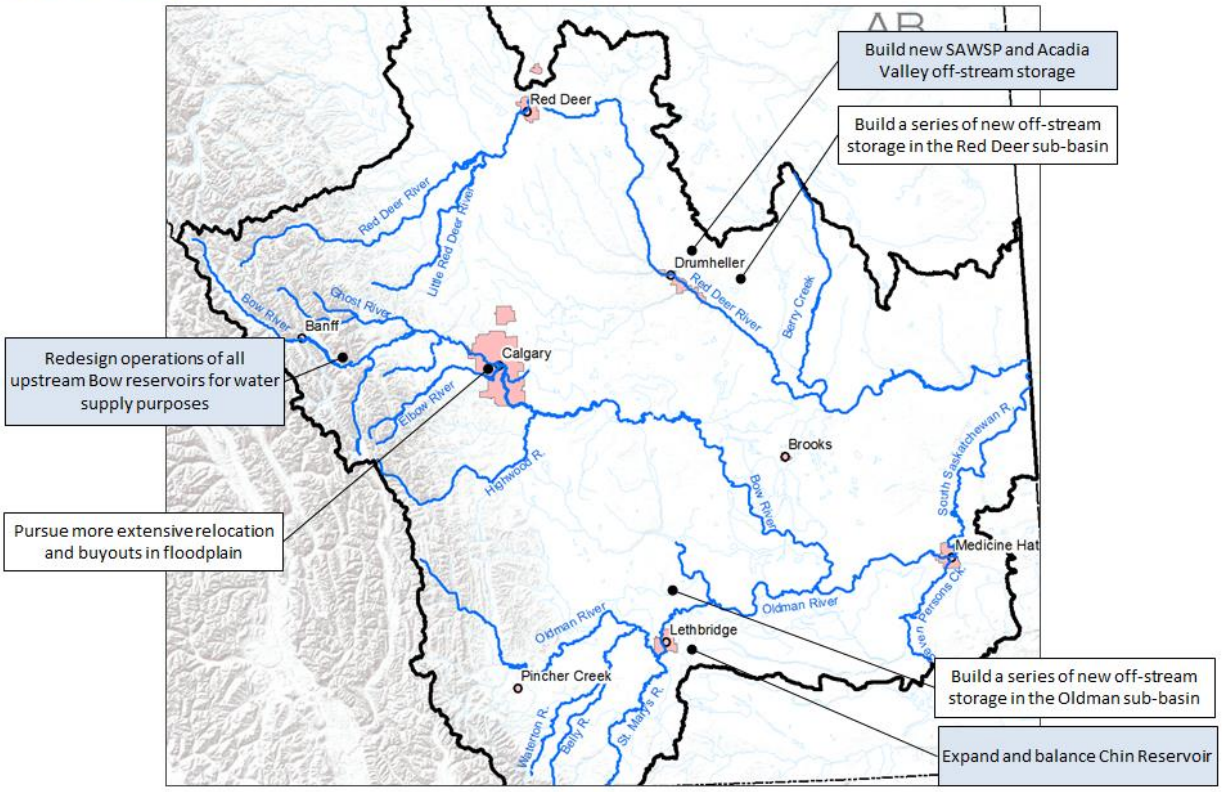
Advance Room for the River conveyance opportunities in the Bow and Red Deer sub-basins to identify and select practical projects that will alleviate constrictions on the rivers and allow greater flow to pass without flooding. This requires datasets already being compiled by AEP, AEP committing to initial high priority projects, and an approximate five-year collaborative process.

Advance Room for the River natural detention opportunities in the Bow and Red Deer sub-basins to identify and select restoration efforts that will hold high flows upstream in a flood event. This requires a commitment to AEP's Watershed Resiliency and Restoration Program and the continued support and work of Watershed Stewardship Groups.

Further apply land use best management practices to minimize impacts of land use changes on the water supply and demand balance of the region. This is currently championed through the South Saskatchewan Regional Plan Secretariat and the South Saskatchewan Regional Plan.

Promote further municipal conservation relative to today to maximize what treatment technology, stormwater management, residential use, and commercial use can contribute to the water balance in the basin, particularly in times of drought. This requires ongoing action from municipalities and industry groups as well as leadership from the Alberta Urban Municipalities Association and the Alberta Association of Municipal Districts and Counties.

SSRB Adaptation Roadmap Level 2



In the map above, strategies in the blue boxes were viewed as "most promising."

Redesign operations and expand, where beneficial, existing reservoirs in the upstream Bow for water supply, drought and/or flood mitigation, and watershed health to change priorities toward highly valued public interest outcomes while maximizing hydro revenues as an important but, in some instances, secondary objective. This requires engaging key water users in a substantial negotiation between GoA and TransAlta, followed by operational support requiring a new governance and decision-making structure supported by advanced forecasting.

Expand and fully balance Chin Reservoir in the Oldman sub-basin to optimize the usefulness of an existing reservoir for providing irrigation water and to alleviate storage demands in other upstream reservoirs, thus keeping more water closer to the headwaters and available to support ecosystems and human water uses throughout the system. This requires a significant capital investment and a shift in operational priorities and control for a major irrigation district facility.

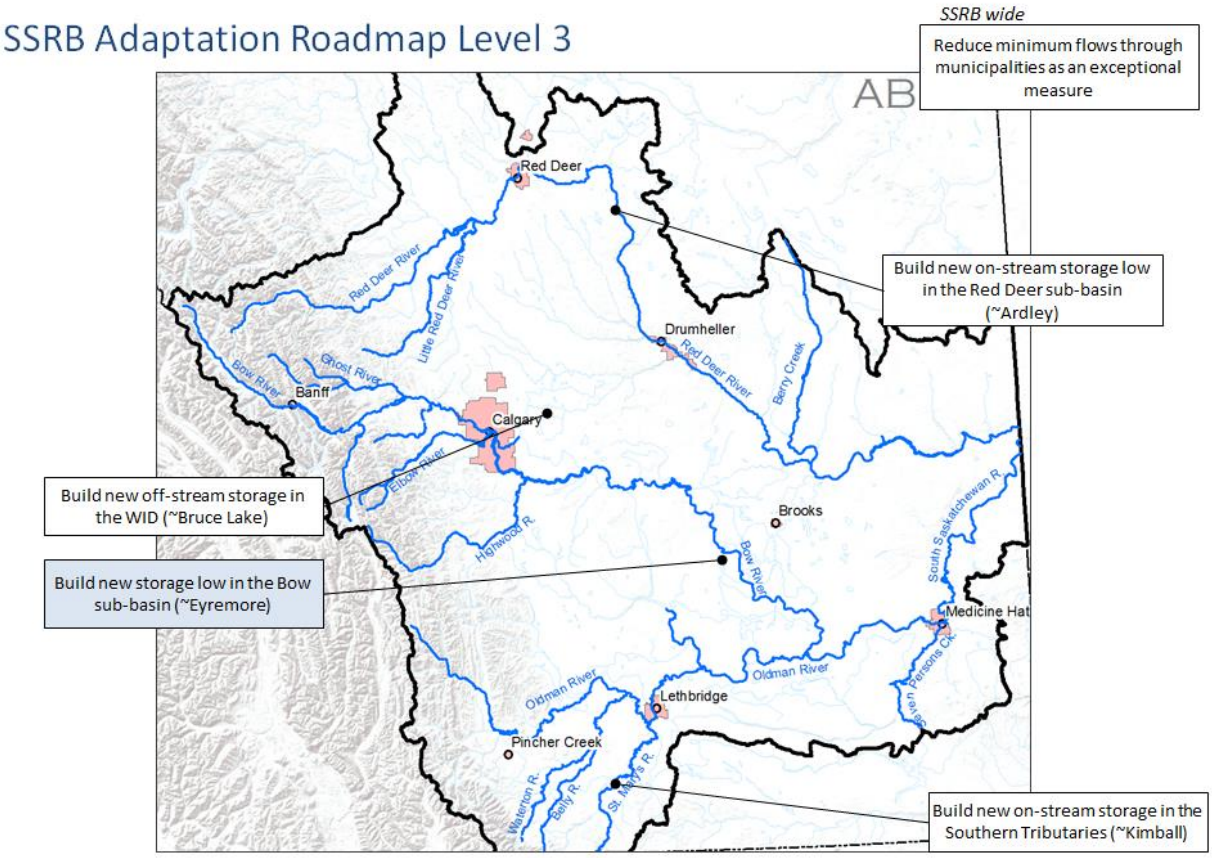
Build new off-stream storage in the Red Deer sub-basin as already proposed in the Special Areas Water Supply Project (SAWSP) and Acadia Valley Project to provide irrigation and municipal water supply to promote growth in regions currently not supported by water storage infrastructure. This project has been under consideration for at least 15 years and requires both approval and funding from GoA to proceed.

Pursue more extensive relocation and buyouts in the Bow and Elbow River floodplains to effectively and permanently mitigate flood damage and reduce the need for upstream mitigation structures. This requires

strong policy leadership and funding from GoA in partnership with municipalities to successfully implement this costly shift that will have significant social impact on individuals and communities.

Build a series of new, small off-stream storage projects throughout the Oldman sub-basin as needed and where feasible to provide water supply for local demands and as a preferred solution over new on-stream infrastructure. This requires a program to enable selection and development of off-stream projects by local beneficiaries with some form of funding mechanism.

Build a series of new off-stream storage throughout the Red Deer sub-basin as needed and where feasible, in addition to the already noted SAWSP and Acadia Valley Projects, to provide water supply for further municipal, industrial and agricultural growth in the lower basin while still maintaining the environmental health of the watershed. As in the Oldman system, this requires a program to enable selection and development of off-stream projects by local beneficiaries with some form of funding mechanism. If further study demonstrates that off-stream storage sites would not be possible or effective, then a midstream facility on the Red Deer system should be moved from Level 3 to Level 2.



In the map above, the strategy in the blue box was viewed as “most promising.”

Build a new on-stream reservoir low in the Bow system, potentially at the previously identified Eyremore site, to supplement Oldman River flows meeting the interprovincial apportionment agreements with Saskatchewan, accommodate some of the irrigation and environmental demands currently on upstream reservoirs in the Bow system, improve minimum flow rates in the downstream Bow, and offer flood mitigation to downstream

communities. This new reservoir may also have hydropower potential. This would be a large infrastructure project requiring extensive engineering and environmental study and a large capital investment.

Build new off-stream storage in the Bow sub-basin, for example the Bruce Lake project already identified and proposed by the Western Irrigation District, to improve water supply security for irrigators and multiple other users in the region east of Calgary. This would require approvals and funding support from GoA.

Build new on-stream storage high in the Southern Tributaries of the Oldman sub-basin, potentially the previously identified Kimball site, and balance this new reservoir with the other reservoirs in the Oldman sub-basin to reduce water shortages for irrigation and municipal users and improve the ability of all reservoirs to maintain environmental flows. This would be a large infrastructure project requiring extensive engineering and environmental study and a large capital investment.

Build a new reservoir midstream in the Red Deer system, potentially at the previously identified Ardley site, to support and enable significant future growth in the sub-basin by providing water supply security for future licences and to offer flood mitigation to downstream communities. This would be a large infrastructure project requiring extensive engineering and environmental study and a large capital investment.

Reduce minimum flows through municipalities and other downstream users as an exceptional measure in drought years to temporarily slow the draining of upstream reservoirs thus ensuring some level of releases for water users and aquatic health over a longer period of time. This requires an accommodation in policy, operational flexibility, and careful application informed by advanced forecasting and science-based understanding of the aquatic impacts of severe low flows.

While discussing adaptation strategies and opportunities, a number of notable aspects related to basin dynamics in the SSRB emerged or were reinforced from prior work. They have a direct or indirect effect on water use and management in the basin. These dynamics are listed here and explained further in section 3.1:

- The observed flows from the United States in the St. Mary River have been considerably higher than the volumes to which Alberta is entitled.
- Apportionment requires ~50% of annual flow by volume be passed to Saskatchewan.
- Further reducing minimum flows could negatively affect aquatic ecosystems.
- The Eastern Irrigation District and Western Irrigation District return flows to the Red Deer River contribute significantly to meeting that system's WCOs during summertime low flow periods.
- Irrigation district expansion will continue to be enabled through improved conservation, efficiency and productivity, not through increased withdrawals from the rivers. This could mean that somewhat greater flow rates may occasionally be needed from Dickson Dam to meet summer WCOs, given lower irrigation return flows from the Bow to the Red Deer.
- Building new water management infrastructure should build adaptive capacity; it should not lead to new licence allocations in closed basins.
- Connections among sub-basins mean that building new infrastructure in one sub-basin could yield benefits in another.
- Operations of TransAlta reservoirs on the Bow interact with many of the other potential adaptation strategies for this river system.
- The forecasting window in the SSRB is extremely short; investment in forecasting resources and systems are imperative for ongoing adaptation.
- The uncertain length of a drought makes it challenging to develop management responses.

- Flood mitigation and drought mitigation can be achieved in the same season, but not at the same time using the same infrastructure capacity. Flexibility and responsiveness to changing conditions are essential.

The work resulting in this report was recognized as a screening level study, after which most strategies would require more detailed study (e.g., project based cost-benefit analysis, engineering feasibility studies, environmental impact assessments, socio-economic analysis, consideration of impacts on landowners and First Nations). It was recognized that the trade-offs between the strategies were partially represented in the models and well-represented in the expertise and experience of working group participants. The best available information was compiled and provided a solid reflection of the operations of the sub-basins both today and into the future. Although the strategies and text in this report use the term "build" with reference to infrastructure, this should not be interpreted as a recommendation or advice to immediately construct that infrastructure; no construction would be started before local consultations and detailed, site-specific studies are undertaken.

Throughout the collaborative work since 2010, a short set of messages has been repeatedly reinforced:

- Activity already underway to develop and promote a market system for temporarily trading or assigning water within irrigation districts and between licensees should continue to be supported. Licence transfers and trades to optimize use of existing licences is a way to manage water shortages, but people need to understand what their options are and how to take advantage of those options.
- The Bow River has a real and immediate need for a water bank that reserves approximately 10% of the annual storage and flows within TransAlta's reservoirs for release in accordance with downstream needs, including improving environmental flows during low flow periods while minimizing shortages to junior and senior licence holders. Establishing a mechanism for managing the water bank for flood and drought should be a high priority. This should be part of a broad watershed agreement between the GoA and TransAlta that includes the elements described in the pertinent Level 1 strategy of the Adaptation Roadmap.
- Each sub-basin needs a framework, beyond what is available today, for sharing shortages. Such frameworks should be developed soon, during "normal" conditions so that they are ready to implement by the time the next drought crisis arrives. Work is needed to determine what components such a framework should have and who needs to be part of it.
- Building on what is already being done, there are a number of practical and immediate actions that can be taken by watershed groups, irrigation districts, municipalities and others in coordination with the Province to expand the adaptive capacity of the SSRB using the infrastructure, regulations and policy in place today. These proactive efforts, for example piloting a higher winter carryover in Travers Reservoir, assessing the dam safety impact of a higher operating FSL on St. Mary Reservoir, and modelling the hydraulic impacts of Room for the River conveyance opportunities along the Bow River, are each important steps in either implementing adaptation or preparing for implementation as warranted by the conditions in the basin.

Adaptive water management will involve implementing and regularly revisiting the Roadmap as this dynamic river basin continues to change and demands grow. To build resilience and sustainability in the face of climatic and environmental change and increased growth, a layered approach will be needed, as no single solution can meet every need. The Roadmap provides a solid foundation on which to determine, refine and implement appropriate actions; adapt the plans; and invest in the science needed to better prepare the SSRB's water management system to respond when new demands and challenges arise.