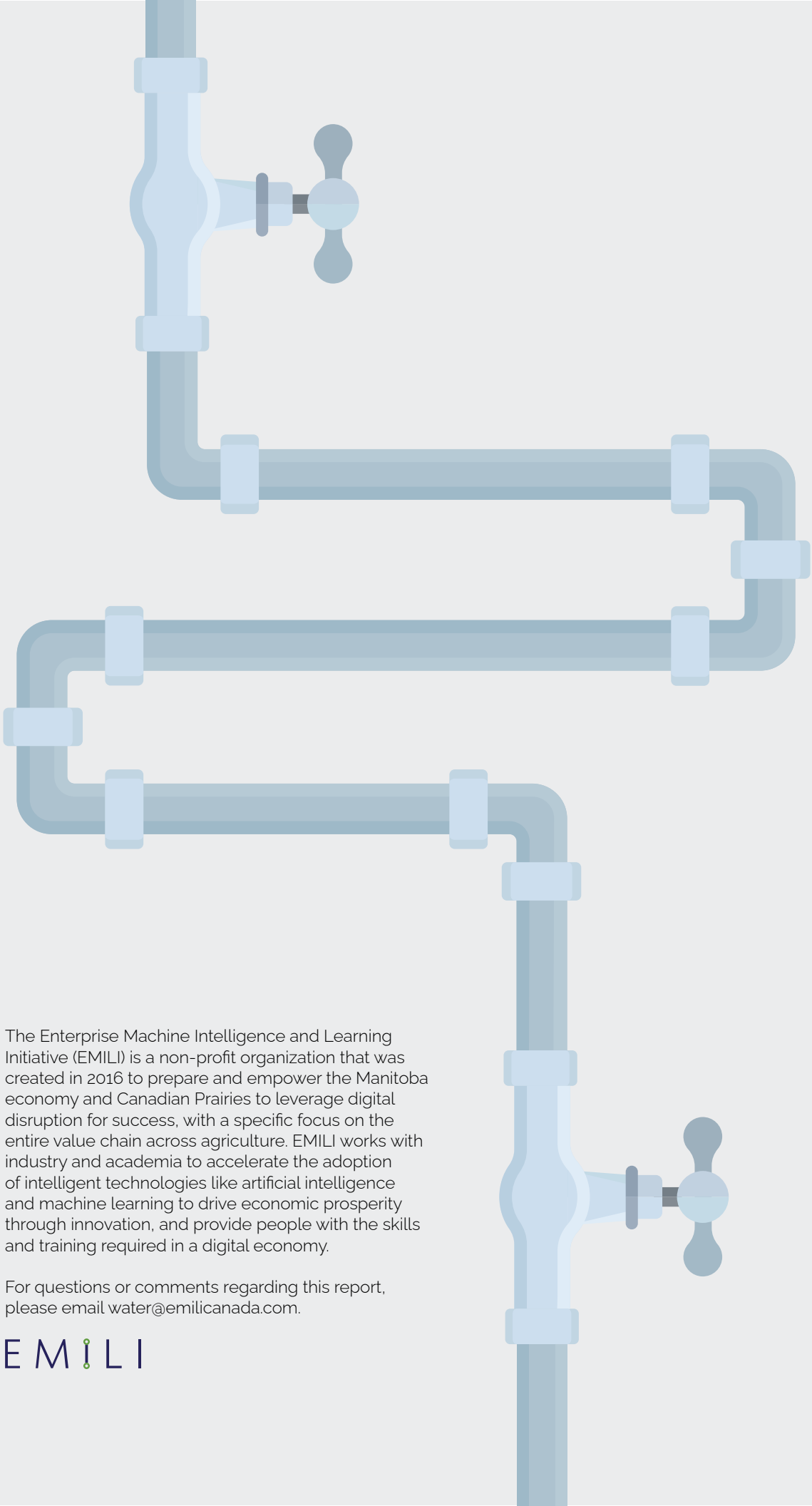
EMILI

Manitoba Water Management Strategy Recommendations Report

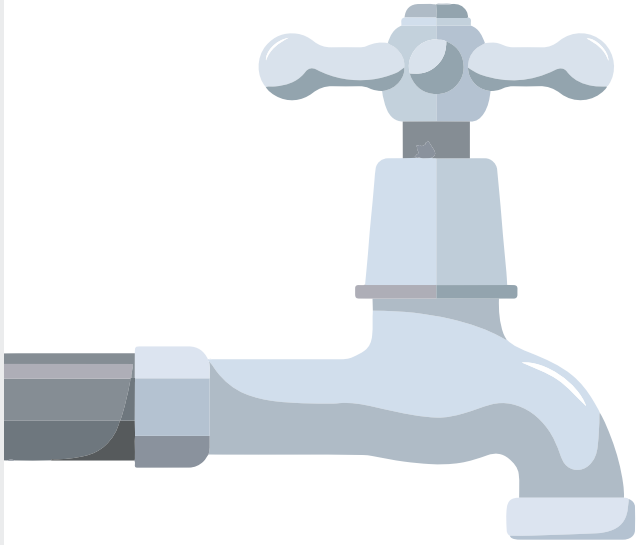


The Enterprise Machine Intelligence and Learning Initiative (EMILI) is a non-profit organization that was created in 2016 to prepare and empower the Manitoba economy and Canadian Prairies to leverage digital disruption for success, with a specific focus on the entire value chain across agriculture. EMILI works with industry and academia to accelerate the adoption of intelligent technologies like artificial intelligence and machine learning to drive economic prosperity through innovation, and provide people with the skills and training required in a digital economy.

For questions or comments regarding this report, please email water@emilicanada.com.

EMILI

Table of Contents



An Introduction

In May 2021, then Minister of Agriculture and Resource Development, Blaine Pederson, announced that the Province of Manitoba was investing up to $1 million into a water strategy fund that would be used to inform the creation of a new provincial water management strategy.

Given Manitoba's last comprehensive water management strategy dates back to 2003, a new strategy is necessary to focus resources and coordinate efforts around mitigating and adapting to climate change, conserving the province's water assets, harnessing emerging economic growth opportunities, and encouraging the sustainable development of communities throughout the province.

"The goal of Manitoba's water management strategy will be to manage water sustainably as a key resource for Manitobans, ecosystems and the economy, while considering the impacts of a changing climate and growing economic and social needs," said Pedersen when announcing the fund. "This work will build on our current tools for water management, the recommendations of the Expert Advisory Council, and through engagement with Manitobans, stakeholders and communities across the province."

The objective of the fund's work would be to determine short-term actions that could be implemented within five years, and long-term actions that would be implemented over the next decade.

This report is a product of the work of the Manitoba-based Enterprise Machine Intelligence and Learning Initiative (EMILI), which was selected by the government to administer the water strategy fund. Founded in 2016, EMILI is an industry-led non-profit organization established to accelerate the growth of the agri-food industry in Manitoba by promoting digital agriculture and digital agriculture technologies across the entire value chain.

EMILI's work in developing the recommendations found in this report, as well as reviewing and approving projects and activities under the fund, has been guided by an oversight committee jointly appointed by EMILI and then Minister Pederson.

The Oversight Committee

- (Chairperson) **Ray Bouchard**, co-chair of the Integrated Water Strategy Committee for the Manitoba Business Council and president and CEO of Enns Brothers Ltd., is a board member of Protein Industries Canada and board chair of EMILI, and former director, then president of the Canadian Association of Agricultural Retailers.
- **Kam Blight**, President of the Association of Manitoba Municipalities, is a fourth-generation farmer, former executive of the International Northern Seed Trade Association and member of the 2011 provincial Flood Task Force, and current reeve of the RM of Portage la Prairie.
- **Elliott Brown**, Assistant Deputy Minister (ADM) of the Water Stewardship Division in the Department of Environment, Climate and Parks, is a former director and then ADM for the international relations division with Manitoba's Department of Intergovernmental Affairs, and previously with the Government of Canada's Treasury Board Secretariat.
- **Neil Cunningham**, acting ADM of the Manitoba Climate and Green Plan Implementation Office, has 15 years of experience within the Manitoba government working on policy and programs related to climate change and energy, including in the Civil Service Commission, Treasury Board Secretariat and the Department of Municipal Relations.
- **Carly Delavau**, senior water supply engineer with the Department of Environment, Climate and Parks, has a PhD in water resources engineering from the University of Manitoba and was previously a forecast engineer with Manitoba Infrastructure's Hydrologic Forecasting and Coordination Branch.
- **Jacqueline Keena**, managing director of EMILI, is a professional agrologist with degrees in agribusiness and public policy, and is a board director for Assiniboine Credit Union and vice-chair of the Women's Enterprise Centre of Manitoba, a not-for-profit that administers small business loans for women entrepreneurs.
- **Chuck Davidson**, President and CEO of the Manitoba Chambers of Commerce, represents a network comprising 68 local Chambers of Commerce across all regions of the province, as well as hundreds of direct corporate and organizational members, focused on championing sustainable economic growth and engagement with emerging issues.
- **Dimple Roy**, director of water management at the Winnipeg-based International Institute for Sustainable Development (IISD), which conducts research on watershed management, nutrient management in agricultural watersheds, analyses related to natural infrastructure and the use of data, and market and policy mechanisms for climate adaptation in Manitoba and around the world. She is also a member of the Expert Advisory Council for the Manitoba Climate and Green Plan.

"The way that climate change affects human beings is almost entirely through water, either too much or too little. So why aren't we talking about water all the time? We need the kind of action on water that we have already happening on the energy transition."

- Tim Wainwright, chief executive of global NGO WaterAid, at COP26 climate summit, November 2021

Executive Summary

In 2021-22 the Manitoba government undertook a series of engagement activities to begin the process of creating a new provincial water management strategy for the province. This process was informed by a report submitted by the Expert Advisory Council (EAC) to the Minister of Conservation and Climate in January 2021, detailing recommendations for how to develop an effective framework for provincial water management in Manitoba.

The ambition for the new water strategy is to create a holistic and integrated approach to water management that will consider water across a wide variety of metrics and sectors. As Manitoba continues into a time of great opportunity and climate uncertainty, the ability to better manage, appropriately value and anticipate our water needs will result in greater environmental and economic prosperity for generations to come.

Given the accelerating rate of climate change and the state of Manitoba's infrastructure and projected population growth, addressing the province's water-related challenges is becoming more urgent and expensive with each passing year.

However, by implementing a sustainable, long-term water management strategy Manitoba can benefit from significant economic development opportunities, while also protecting local ecosystems, building more resilient communities and strengthening the provincial economy. Doing so will require moving as fast as possible to enact a mix of both short-term actions within the next five years, and medium to and long-term actions over the next 5-10 years.

This report echoes many of the EAC's recommendations, and also builds off that work by fulfilling two of them:

- Recommendation 9(a) – Include "municipalities, Indigenous organizations, business, and knowledge institutions such as non-governmental organizations and academia, and other stakeholders in the strategy development."

- Recommendation 9(b) – Involve "business and industry to ensure that economic perspectives on the economy, circular economy, and sustainable "green" market-based mechanisms are included."

EMILI's work consisted of foundational research and analysis during Summer 2021 and in-depth interviews with key stakeholders and experts from September 2021 to March 2022. Four virtual group engagement sessions – on agriculture/agri-food processing, environment and ecosystems services, community and economic growth, and infrastructure and resilience – were held in January 2022. The strategic water projects administered by EMILI and financed through the Province's water strategy fund were opened for proposals in September 2021, launched in December 2021 and concluded in May 2022.

Some Indigenous persons and organizations contributed to the findings in this report through their involvement in key stakeholder interviews and group engagement sessions related to the general themes of economic development and environmental protection. However, in recognition of the unique knowledge and insight that Indigenous communities and groups in Manitoba can contribute to a provincial water management strategy, the Province of Manitoba has committed to launching its own separate Indigenous engagement process. That process was still in development at the time of EMILI's submission of this report to the Manitoba government.

The following is not a prescriptive course of action, nor an exhaustive list of water-related issues faced by Manitoba. The key findings and recommendations that follow are presented in no specific order of importance, and have been developed based on research into best practices in other jurisdictions; feedback and insights gained through engagement with stakeholders in Manitoba; and the findings and expert analysis contained within three strategic water projects commissioned by EMILI and completed by leading global water engineering firm Stantec, in conjunction with provincial government staff. The table of suggested action items has been reviewed and approved by the members of the Oversight Committee.

The desired outcome of presenting this report to the Province is to support the government's creation of a new holistic, inclusive long-term provincial water management strategy – one that is informed by the needs, priorities and insights of stakeholders from different sectors, communities and industries across Manitoba.

SWOT Analysis of Manitoba's Water Resources

Strengths

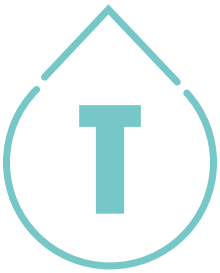
- Relative abundance of water compared to other jurisdictions
- Hydropower provides clean electricity for business attraction
- Established flood protection strategies and infrastructure
- Effective on-the-ground organizations in Watershed Districts and Manitoba Water Services Board
- Indigenous knowledge and perspectives on water management
- Strong engagement from diverse stakeholder groups interested in a water strategy for economic and environmental benefit

Weaknesses

- Gaps in water data and its availability for stakeholders
- Lack of communication from government to stakeholders
- Frequent shuffling of water responsibilities between departments
- Aging water infrastructure including for municipal water delivery, wastewater treatment, and water-ways such as drains and bridges
- User fees don't reflect true cost of water delivery and effect on natural assets
- Provincial construction industry will require time to scale up to execute large-scale infrastructure projects due to current size and lack of experience

Opportunities

- Expanding irrigation networks can boost crop production and mitigate drought risk
- Strong commodity prices could enable implementation of solutions to sustain long-term growth and productivity potential, including in agri-food processing
- Phase in nature-based solutions as alternatives to engineered infrastructure where appropriate
- Harness funding available from the federal government and other green financing/investment sources
- Expand watershed-based land-use planning
- Increase conservation through emulating successful public education campaigns from other jurisdictions



Threats

- Climate change will bring more extreme water variability
- Population growth will increase demands on water infrastructure
- Diversion and irrigation projects in upstream jurisdictions could affect Manitoba
- Allure of short-term economic growth could undermine long-term goals of water management
- Escalating land values disincentivize private landowners from protecting natural assets
- Changes in governments or departmental mandates may be disruptive to water strategy's management and multi-decade outlook

Key Findings and Recommendations

Manitoba is already experiencing symptoms of acute water stress – and must act quickly to avoid worsening consequences in the near future

Manitoba's relative abundance of water resources compared to other jurisdictions obscures how much of this supply is located away from the areas that need it most. The Assiniboine River and Pembina Valley regions in particular have the greatest mismatch in supply and demand, negatively impacting agriculture and triggering moratoriums on wet industry in some areas, while hindering economic development projects and impacting residents' quality of life in others. In the Summer of 2021, the Canadian Drought Monitor classified nearly all of southern Manitoba as being mired in exceptional drought conditions, some of them the worst on record. Feedback from stakeholders suggests that issues around lack of access to water are already causing some businesses to alter their medium-term growth and investment plans. During the group stakeholder engagement sessions organized by EMILI in January 2022, 75 percent of all 150-plus attendees said it was either 'likely' or 'highly likely' that their business or organization would be negatively impacted by water issues within the next 2-3 years. Dave Sauchyn, director of the University of Regina's Prairie Adaptation Research Collaborative and one of the expert panelists at the group engagement sessions, has predicted that the Canadian Prairies face worsening drought conditions in the future: "Our summers are getting longer, our winters are getting shorter. And so there are more days in which we're losing water each year. And so when we have a combination of a lack of precipitation, and more days of water loss, you can expect that in a warming climate, the droughts [will] have greater impact and severity."

Flexibility, collaboration, persistence, communication and continuous strategic leadership will be key to sustaining any long-term strategy, including through changes in ministers or governments

For a province as large and socioeconomically diverse as Manitoba, there is no one-size-fits all approach to water management. Moreover, even at the best of times water management will still remain a complex problem, and will likely never reach a point of resolution – even after many years of effort. Based upon research detailed later in this report, other jurisdictions like the Netherlands, California and Israel have each shown that achieving successful outcomes requires a commitment to careful, transparent planning and regulations; significant and sustained investment; constant supervision and evaluation; and strong, clear, on-going public messaging. Implementation will always be more difficult in practice than on paper and infrastructure projects at times suffer setbacks. The new strategy should also be a living plan, with mandatory reporting, review and revision periods built in from the start. In a June 2021 report, *Toward a National Adaptation Strategy for Canada: Key insights from global peers,* the International Institute for Sustainable Development (IISD) points out that strategies are "broader in scope than plans," and that for strategies to be successful, planning processes must be "continuous and iterative." Fundamental to this process in Manitoba may be developing a dedicated team or entity within government that deals with water in the same way that Tourism Manitoba or the Province's newly created Economic Development Board provide governmental ownership of their respective areas, particularly around non-public facing aspects. This includes building relationships and initiating dialogue across sectors, offering policy support, marshaling resources, supplying long-term vision and objectives, promoting cross-departmental integration and ensuring action plans evolve alongside changing conditions.

The wellbeing of local ecosystems could be jeopardized by an overly aggressive pursuit of short-term economic growth agendas

There are significant domestic and international market opportunities available to Manitoba, particularly in agriculture and agri-food processing. Ensuring that economic opportunities can be harnessed long-term, however, may require a conscious effort to cultivate a strategically diverse mix of industries in the province, being mindful of the added pressure that the attraction and retention of businesses that are heavy water users places on municipal water and wastewater infrastructure. When it comes to expanding irrigation, an outlook rooted in responsible, sustainable growth is required as well. According to a study by Stantec, commissioned by EMILI, into the potential return on investment for expanding irrigation in Manitoba, the potential surface water available for licensing after accounting for instream flow needs is around 750,000 acre-feet annually. This volume of water could support up to approximately 1.5 million acres of agriculture converted from dryland operations to irrigated agriculture, with the potential for additional per acre marginal profit returns ranging from $280 to $958. However, the study also suggests that while irrigation systems can indeed help save water while also boosting production, there

is a limit to which they can be deployed before triggering diminishing returns. Also recommended is that, as the amount of irrigated lands increase, the Province should increase its monitoring and enforcement efforts to ensure that current policies will protect future instream flows adequately. Research released by the Global Institute for Water Security at the University of Saskatchewan in August 2021 suggests too that to manage overall aggregate irrigation water demand on a multi-decade time scale, a plan to gradually taper water usage over time may also be necessary, so that the water savings from new technologies are not just lost by being readily applied somewhere else.

Government should adopt a client-centred approach to service for water users, to enhance transparency, simplify the client experience and support the establishment and achievement of service standards

Aligning all water-related work among different government departments and improving coordination and communication between government and stakeholders need to be primary goals of the new water management strategy. At the moment, water issues are fragmented across various authorities in different government departments – departments which tend to also change names and mandates regularly. This has been frustrating for stakeholders and produces added red tape for economic development projects and regional water co-operatives. Over 70 percent of attendees at the group engagement sessions organized by EMILI said they felt it was 'important' or 'very important' that Manitoba create its own standalone water agency. Although, this may represent more of a strong expression of desire for change from the current situation than actual wishes for the creation of a new government agency. One option would be to create and promote a "single window" type of capacity and touch point within existing government structures to initiate and approve water projects, respond to stakeholder concerns, and re-route water user inquiries to the proper government departments. Making water data and information resources more widely available online could also alleviate some service bottlenecks. No matter which tactics are chosen, successful outcomes will require the Province to be committed to providing the additional resources necessary to raise service standards for water users to where they generate the required level of stakeholder trust and satisfaction, and public buy-in necessary to achieve the objectives of a new provincial water management strategy.

The Province could draw more investment and business to Manitoba if it provided the private sector with extra help navigating water-related issues and regulations

Manitoba has tremendous economic growth and investment potential given its central location in North America and established hydroelectric (i.e. green) energy grid. Well-managed water resources will further underline these competitive advantages. However, some stakeholders have said they can no longer keep track of which government departments and staff they are supposed to talk to about water infrastructure, flood/drought relief, economic development, irrigation expansion, and more. Assembling a well-staffed, well-resourced support unit to fulfill this role by streamlining processes and increasing outreach and support to the private sector could make Manitoba a more attractive place for industry and others to invest in. If businesses instead continue to feel left on their own to figure out the Province's water requirements or incentive programs, they will likely set up in, or relocate to other jurisdictions where doing so doesn't consume so much of their time and resources.

Developing a province-wide network of water retention, storage and conveyance infrastructure could be key to increasing climate change resilience

During the group engagement sessions, climate change was selected in all four sessions as the top threat to water management in the province. Mitigating the arrival of more frequent and sudden flooding and drought conditions will first require the fundamental shift from viewing and addressing water issues on a municipality-by-municipality basis to implementing networks of projects on a regional and watershed-level. Among these initiatives should be the development of strategically placed and interconnected multifunctional storage sites – both engineered and nature-based – in the most at-risk regions, as determined by geospatial analysis and climate risk modeling, particularly throughout southern Manitoba. The various nodes on this network will work together to capture water in times of excess moisture, retain a base level of supply in regular times, and distribute water to municipalities and producers for drinking water and irrigation during drought. Regional water cooperatives can play an important role in the development/implementation of these networks, as could the Manitoba Water Services Board and watershed districts, which will ensure local knowledge and expertise is included.

A sunflower crop outside of Winnipeg. Effective water management will be vital for Manitoba's agricultural producers to take advantage of long-term, sustainable growth opportunities. *Photo: Murray R Grant, Getty Images, Canva*

To pay for required infrastructure upgrades, the Province should partner with the federal government wherever possible

Most of Manitoba's infrastructure stock is several decades old; it was not built to deal with the levels of flooding, drought and water demand set to occur in coming years. Upgrading existing infrastructure and building new dams, reservoirs and conveyance pipelines – while also protecting and maintaining nature-based solutions – will cost billions of dollars. Manitoba will be unable to afford this expense on its own. In recent years, the Province has deferred to local municipalities to take leadership over initiating water-related infrastructure projects, rendering these projects less eligible for federal funding. Money available from the federal government is thus being left on the table. More concerted effort and resources needs to be committed to creating a better, more accessible system that connects available federal funds to provincial water initiatives. For example, through Ottawa's new Nature Smart Climate Solutions Fund.

Prioritizing nature-based solutions could be a more cost-effective means to address water issues, but that will require a change in processes and mindset

Phasing in a requirement to consider nature-based solutions – where appropriate based on scale and function – as an alternative in infrastructure funding proposals could help accelerate the utilization of natural infrastructure. Nature-based solutions tend to cost less in the long-run because, if properly maintained, they don't break down over time like engineered infrastructure. However, nature-based solutions, which essentially consist of a chain of smaller sites or ecosystem linkages working collectively to deliver benefits, don't always meet the minimum cost and size scale required to be eligible for large infrastructure grants and financing. According to Roy Brooke, Executive Director of the Municipal Natural Assets Initiative and expert speaker at the group engagement session on infrastructure and resilience, another effective way to prioritize natural infrastructure is by supporting municipalities with resources and expertise to help them develop inventories of their natural assets and give these assets a proper valuation, which helps with decision-making around land use planning. Developing or expanding creative incentive programs, like the GROW Trust, to encourage landowners to protect natural infrastructure on their property may also be necessary.

The Province needs to do a better job of informing stakeholders about its determined hierarchy of water access rights during times of severe shortages

Provincial priorities and the decision-making process around how water supplies and restrictions are determined during times of severe scarcity is extremely important information for stakeholders to know. However, it is not something that is widely discussed or communicated at the moment, preventing producers in particular from making investment and contingency plans accordingly. As water issues become more contentious amid greater extremes of moisture in the future, it will also be important to have a conflict resolution mechanism in place to arbitrate grievances that will inevitably arise as groups of stakeholders feel their interests are being displaced for the sake of others.

Filling water knowledge and data gaps will be just as important as fixing water infrastructure gaps

The Stantec Conservation and Efficiency study corroborated stakeholder suggestions to conduct a sector-by-sector analysis of water needs/demands to create a baseline understanding of the current water consumption situation in the province. Key stakeholders also expressed the need for better LiDAR coverage and more sensors and monitoring instrumentation on waterways to help provide better real-time information about water supplies. Making this information available to all stakeholders through a centralized online water knowledge platform could be a key component of improving coordination of water management efforts and emphasizing water issues at the provincial and regional levels. Government and municipal staff involved in economic development work also need to be better informed and equipped to understand the implications of water and water limitations for their rural municipality or area. To continue driving economic growth, businesses and investors will want to know what a particular area's water budget is, and the future climate risk trends that will affect that budget – and to what degree those risks can be offset through conservation and efficiency increases. A new provincial water strategy also creates the opportunity for the Province to provide the guidance and technical support necessary to standardize data protocols and clarify metadata requirements for the many entities in Manitoba that are collecting water data from outside of government – from community-based water monitoring networks, to consulting groups and others. If these supplementary datasets can be standardized and combined on a digital online knowledge platform, it will hasten the closure of several of the government's current water data gaps.

Image: RMED Survey, 2022

Sustained strategic communications will be important to justify a possible increase to user fees

The experience of Israel shows how phasing in higher fees for water can help to offset some of the cost of maintaining and upgrading water infrastructure (particularly wastewater), while also working as an incentive for residential and commercial users to be more efficient with their water use, thereby easing demand-side pressures. But, according to economists consulted as part of key stakeholder interviews, implementing price increases would have to be phased in incrementally – no more than double-digit increases per year. Price increases would also need to be supported by public education and awareness-raising to enable users to see how these increases fit within the larger overall picture of a long-term water management strategy by asking users to do their part. In conjunction with conservation measures similar to those recommended in the Stantec Conservation and Efficiency study, a strategically crafted public messaging campaign from 2008-2010 in Israel enabled the doubling of user fees and resulted in a 24 percent reduction in urban per capita water use. More consistent public messaging could also help to reduce the amount of incorrect information and misperceptions around provincial water initiatives that are currently circulating among some stakeholders – something that was made clear during the stakeholder engagement processes that contributed to this report.

Suggested Action Items

Per the Province's 11 Focus Areas

Given the growing urgency around provincial water issues, Manitoba would be best served if planning for these action items began immediately. The timelines included below indicate the windows in which they could then be implemented.

***High impact actions that could be initiated before the end of 2022**

Focus 1

Enhance water for sustainable development

Short-Term (<5 years)	Medium to Long-Term (5-10 years)
***1.1** | Conduct sector-by-sector water needs analysis to determine future water needs, while considering the impacts of climate change on water demand	1.7 | Create networked multifunctional water storage and distribution infrastructure
1.2 | Develop a strategy with industry partners on how to make coinvestment in water projects more favourable – especially by drawing funding from the Canadian Infrastructure Bank	1.8 | Address serious water shortage/limit issues in sub-basins and watersheds in southern Manitoba
1.3 | Work with municipalities and water providers to account for population and industry growth in water and wastewater planning	1.9 | Expand irrigation infrastructure based on recommendations found within Stantec study on the return on investment in irrigation in Manitoba
1.4 | Substantially increase funding availability and streamline approvals for water infrastructure projects	Focus area also supported by suggested action items 2.3, 2.4, 2.5, 2.6, 3.2, and 3.3
1.5 | Embrace opportunities for value-added agri-food processing in areas with adequate water supplies	
1.6 | Increase Manitoba Water Services Board funding to enhance its mandate to assist municipalities and water cooperatives to develop potable water infrastructure, including regional solutions	

***Other stakeholders that could hasten implementation:** Association of Manitoba Municipalities, agricultural associations, large industrial users, International Institute for Sustainable Development, regional water co-operatives, municipal governments and other water providers, Rural Manitoba Economic Development Corporation, Manitoba Business Council, Manitoba Chambers of Commerce

*Stakeholders included in each of the focus areas are merely initial suggestions, not an exhaustive list

Focus 2

Make every drop count through efficient water use

Short-Term (<5 years)	Medium to Long-Term (5-10 years)
*2.1 | Launch significant, sustained public education campaign on water conservation	2.5 | Provide financial tools/incentives for producers to adopt latest technologies around water reuse, efficiencies, retention and protecting benefits of natural capital
2.2 | Implement effective water pricing strategies to encourage demand management and build reserves	2.6 | Implement policies to increase water use reporting compliance by licensed users and irrigators, such as through annual renewal requirements or other incentives or penalties
2.3 | Leverage the Government of Manitoba's promotional partnership in the EPA WaterSense program and share relevant information and activities with water providers and water users	2.7 | Conduct a provincial water census, based on U.S. Geological Survey's National Water Census approach, at a recurring interval – e.g. every 5-10 years
2.4 | Develop and make available a model water conservation plan for customization by and use of water providers	

Other stakeholders that could hasten implementation: Manitoba Association of Watersheds, regional water co-operatives, Association of Manitoba Municipalities, agricultural associations and individual producers, municipal governments and other water providers, Manitoba Business Council, Manitoba Chambers of Commerce

Focus 3

Support coordinated water management and governance across watersheds and basins

Short-Term (<5 years)	Medium to Long-Term (5-10 years)
3.1 | Government should adopt a client-centred approach to service for water users to enhance transparency and simplify user experience	3.5 | Ensure land development plans are coordinated and aligned with integrated watershed management plans
*3.2 | Create a dedicated and specialized team within government that can help private businesses navigate water-related requirements	3.6 | Increase engagement and collaboration with other jurisdictions on water management and transboundary water issues
*3.3 | Support and fund watershed districts to expand water work at regional/watershed levels	Focus area also supported by action items 1.3, 2.3, 2.4, 4.1 and 5.1
3.4 | Implement a fair, transparent and well-funded water project planning and funding process	

Other stakeholders that could hasten implementation: Manitoba Association of Watersheds, regional water co-operatives and water providers, Red River Basin Commission, Assiniboine River Basin Initiative, Rural Manitoba Economic Development Corporation, Prairie Provinces Water Board, International Joint Commission. Manitoba Planning Districts, Manitoba Business Council, Manitoba Chambers of Commerce, municipal governments

Focus 4

Advance Indigenous inclusion in water management

*suggestions based on limited amount of Indigenous engagement

Short-Term (<5 years)	Medium to Long-Term (5-10 years)
4.1 | Identify capacity-building needs in Indigenous communities so they have the resources to collaborate with government and other partners on water management	4.3 | Encourage federal government to address drinking water crises in Indigenous communities
4.2 | Partner with Indigenous groups on research and monitoring, including around natural infrastructure projects and nature-based solutions, and/or other aspects of water management	4.4 | Incorporate Indigenous knowledge into water management

Focus 5

Increase understanding of groundwater supply and quality and its interrelationship with other parts of the environment

Short-Term (<5 years)	Medium to Long-Term (5-10 years)
5.1 | Assist municipalities with developing groundwater conflict resolution protocols	5.3 | Create a plan for identifying and addressing groundwater quality issues
***5.2** | Enhance understanding of groundwater resources in Manitoba for decision making, including aquifer extents, water levels, recharge estimates and aquifer sustainable yields	Focus area also supported by suggested action items 7.3 and 9.1

Other stakeholders that could hasten implementation:
Academia, landowners, Association of Manitoba Municipalities, municipal governments

Focus 6

Build our resilience to a variable and changing climate

Short-Term (<5 years)	Medium to Long-Term (5-10 years)
*6.1 | Create public education resources about water management and climate adaptation in the most at-risk areas for extreme weather events and their impacts, including drought-related water shortages and more frequent and severe flooding	6.3 | Create policies for managing extreme weather events (or climate impacts) that are clear and transparent
6.2 | Explore possibilities for new green financing instruments to diversify and enhance funding available for natural infrastructure projects	6.4 | Work with industry to promote perimetric insurance as a way to bolster climate adaptation and drought recovery
Focus area also supported by suggested action items 1.8, 1.9, 2.4, 3.3, 5.2, 7.1 and 7.4	6.5 | Make significant investments into construction of water retention infrastructure to deal with water variability

Other stakeholders that could hasten implementation: Manitoba Association of Watersheds, industry and agricultural associations, landowners/producers, Manitoba Business Council, Manitoba Chambers of Commerce, Association of Manitoba Municipalities and municipal governments

Focus 7

Address our water infrastructure challenges and opportunities

Short-Term (<5 years)	Medium to Long-Term (5-10 years)
*7.1 | Put more effort into obtaining and utilizing maximum amount of federal funding available for water infrastructure	7.5 | Accelerate rollout of rural broadband to meet real-time data transmission and access capabilities required by a cutting-edge water strategy
7.2 | Explore ways to package multiple small-scale natural infrastructure projects together to meet eligibility and scale requirements of green bond markets	7.6 | Support and expand regional water supply networks
7.3 | Invest in capacity-building at the provincial level around understanding of natural infrastructure and its benefits throughout the hydrological cycle	7.7 | Invest in engineered and natural storm water solutions to help municipalities cope with more frequent instances of excess moisture
7.4 | Continue to evolve and refine operating guidelines for multi-use reservoirs to account for climate change	

Other stakeholders that could hasten implementation: Manitoba Association of Watersheds, academia, regional water co-operatives and water providers, engineering systems consulting groups, Rural Manitoba Economic Development Corporation, Manitoba Business Council, Manitoba Chambers of Commerce, Association of Manitoba Municipalities and municipal governments

Focus 8

Improve surface water quality

Short-Term (<5 years)	Medium to Long-Term (5-10 years)
8.1 | Step up enforcement of existing regulations around water quality, water use and drainage	8.5 | Update and enhance regional nutrient management plans
8.2 | Allocate funding for Manitoba Water Services Board and water providers to specifically address backlog of wastewater treatment upgrades	8.6 | Increase the amount of sensors and monitoring instrumentation on waterways
8.3 | Create incentives for producers to increase soil moisture holding capacity to reduce agricultural run-off	8.7 | Develop incentives for home owners and developers to slow water flows during storm periods
***8.4** | Identify hotspots throughout the province that consistently struggle with poor water quality and prioritize mitigating actions in these areas	Focus area also supported by suggested action items 7.3, 9.1, 9.4, 9.5, 9.6 and 10.3

Other stakeholders that could hasten implementation: Lake Winnipeg Foundation, Ducks Unlimited, Manitoba Association of Watersheds, Manitoba Association of Cottage Owners, Environment and Climate Change Canada (Lake Winnipeg Basin Program)

Focus 9

Protect biodiversity and support aquatic ecosystems health

Short-Term (<5 years)	Medium to Long-Term (5-10 years)
9.1 | Increase data collection within watersheds to better understand and monitor ecosystem health	9.5 | Emphasize nature-based solutions on lands with high ecological value
9.2 | Phase-in requirement to consider nature-based alternatives or complements to any engineered infrastructure proposals	9.6 | Build off the Protected Areas Initiative to expand Manitoba's network of protected landscapes
9.3 | Consider lessons learned from the Manitoba Hydro/Government of Manitoba CAMP Program and how aspects could be applied to other regions of the province	Focus area also supported by suggested action items 3.5, 3.6, 4.4, 8.1, 8.3, 8.5, 11.3
9.4 | Leverage federal money for carbon reduction and tax incentives for agricultural producers to enhance wetland protection	

Other stakeholders that could hasten implementation: Ducks Unlimited, Manitoba Association of Watersheds, Manitoba Habitat Heritage Corporation, Lake Winnipeg Foundation, IISD (Experimental Lakes Area), Manitoba Hydro, other conservation groups

Focus 10

Improve the information and knowledge available for effective water management and decision-making

Short-Term (<5 years)	Medium to Long-Term (5-10 years)
***10.1** | Create user-friendly, publicly accessible central online repository of water and climate change information and resources	10.4 | Assist municipalities with asset management practices to boost capacity for infrastructure investments
10.2 | Improve the water management and issues knowledge of provincial and municipal government staff engaged in economic development	Focus area also supported by suggested action items 1.1, 1.3, 2.3, 2.4, 2.7, 3.1, 3.6, 4.1, 5.2, 7.3, 8.4 and 9.1
***10.3** | Increase LiDAR data coverage across the province	

Other stakeholders that could hasten implementation: International Institute for Sustainable Development, Manitoba Association of Watersheds, academia, Association of Manitoba Municipalities, municipal governments, Prairie Climate Centre, Manitoba Hydro

Focus 11

Enhance engagement and participation of Manitobans in water management

Short-Term (<5 years)	Medium to Long-Term (5-10 years)
11.1 | Use watershed districts as a delivery vehicle for large-scale public education campaign around water	11.4 | Begin building a culture of understanding of water systems at the public school, early grades level – subject matter could include hydrology, energy, ecology, history and social dynamics
***11.2** | Proactively communicate to the public about contingency protocols in place to deal with extreme weather — particularly water shortages and flood mitigation	Focus area also supported by suggested action items 2.1, 2.3, 2.4, 4.2 and 6.1
11.3 | Continue to engage with citizen science program being run by the Lake Winnipeg Foundation as a means to supplement provincial data gathering	

Other stakeholders that could hasten implementation: Manitoba Association of Watersheds, Lake Winnipeg Foundation, citizen science groups and school divisions

Proposed Monitoring, Evaluation and Accountability Mechanisms for Continued Strategy Development

In its January 2021 report to the Minister of Conservation and Climate, the EAC provides several recommendations to ensure accountability and responsibility for a new water management strategy. Many of these have been reiterated in part or verbatim below, with specific dates having been adjusted by one year from the EAC's original recommendation of a provincial water strategy being released by December 31, 2021.

- Create and publicly release initial framework for new water management strategy, and accomplish three suggested short-term, high-impact action items by no later than December 31, 2022, before publishing full water management strategy by Spring 2023;

- Ensure that accountability and responsibilities in government for implementing the strategy are clearly defined. This could include:
  - Creating publicly-available action plans for each focus area within the new water strategy, complete with specific goals, timelines, milestones, resource requirements and designated ownership of the action plan within each focus area;
  - Identifying and appointing independent, recognized subject matter experts experienced in project management to work with departments to execute each action plan.

- Identify and assess how the strategy, and water more generally, affect the government's other strategic plans in other sectors – e.g. agriculture, tourism, mining, rural development, etc.

- Enshrine the new strategy in legislation and regulation that prescribes roles and responsibilities of current and new government structures to support sustained action over the long term. This could include:
  - Create a formal, permanent interdepartmental water working group responsible for collaboration and integration of water issues within government;
  - Have the EAC create a standing committee on water, per its powers under the Climate and Green Plan Act Section 7(2)(3), to provide advice and oversight to government on an ongoing basis, specifying the committee's responsibilities by Terms of Reference;
  - Enshrine certain water-related conditions and considerations directly into legislation, ensuring a coordinated and integrated approach to water management across government and all sectors.

- Develop a water strategy funding framework for strategy implementation and development. This could include:
  - Creating new and innovative financial instruments outside of government to avoid sole reliance on the public sector – such as water offsets (particularly for industry and other large water users), green bonds, green financing, innovative pricing regimes, water quality trading, public-private partnerships, and other potential investment opportunities focused on nature-based solutions.

- Develop data protocols and standardized water indicators for use across the the province, based on EAC recommendations.

- Develop and implement a targeted communication plan for the water strategy, and support with necessary resources and funding. This includes:
  - Create list of stakeholders to be engaged as part of strategy review/revision process; ensure ongoing communication with stakeholders leading up to launch of process;
  - Create youth-friendly messages and platforms, and prioritized, targeted, specific communications across business, industry, and other sectors.

- Develop and publicly release state of water report cards and high-level strategy progress updates every two years.

- Commit and plan to comprehensively report on the water strategy's implementation and achievements no later than four years after the release of the strategy, and every 5 years thereafter, launching a strategy review and update process after each reporting cycle.

Pine Falls hydroelectric dam. Water and energy are inextricably linked in Manitoba. *Photo: MB Hydro*

State of Water in Manitoba

Water plays a fundamental role in the wellbeing of Manitoba's economy, environment, communities and recreational areas. The health and management of provincial watersheds going forward will determine Manitoba's ability to both harness new economic opportunities and accommodate population growth, and develop resiliency measures around climate change. Despite being considered a renewable resource, water is also finite — once supplies are depleted, there is no way to create more on demand. This reality was underscored during Summer 2021 as record-breaking drought conditions across Manitoba caused severe losses in the agricultural sector, affected hydroelectric energy production and led to water restrictions in some communities.

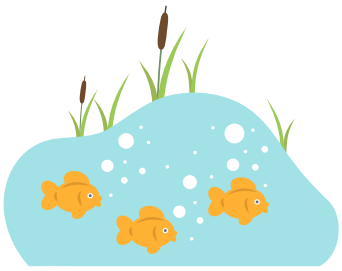
A new long-term strategy for the stewardship of Manitoba's water assets is thus critical to environmental conservation and increased prosperity in the province amid escalating developmental, economic and climate pressures. This is especially true given how Manitoba's geographical location means it is reliant on upstream jurisdictions for some 70 percent of the province's annual water renewal.

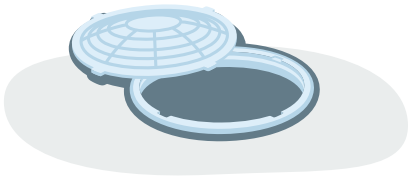
Recent Progress in Water Management

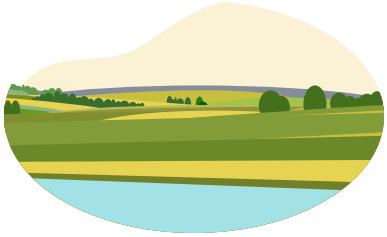
The Government of Manitoba's last comprehensive water strategy dates back to 2003, when the prime focus was on improving provincial water quality, particularly in Lake Winnipeg. Other objectives include supporting conservation, better managing water use and allocation of the water supply and improving drainage capacities to help mitigate flooding. This strategy and the work resulting from it formed the basis for additional water management efforts: the 2014 Surface Water Management Strategy and the province's inaugural Drought Management Strategy released in 2016. Alongside climate, jobs and nature, water is also one of the four key pillars of Manitoba's 2017 Climate and Green Plan, which emphasizes the need to manage flood and drought, as well as protect water quality, plan intentionally around watersheds, and support and promote best practices related to agriculture and land use.

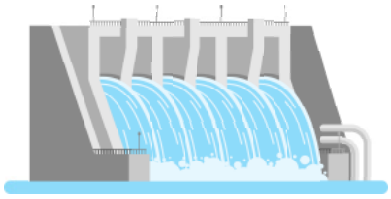
According to a 2020 consultation document from the Expert Advisory Council (EAC) — a group established in 2018 to guide the implementation of the Climate and Green Plan — this previous work around water management has already led to some notable actions.[1]

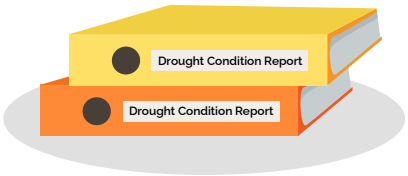
2003 MB Water Management Strategy: Objectives Achieved by Province











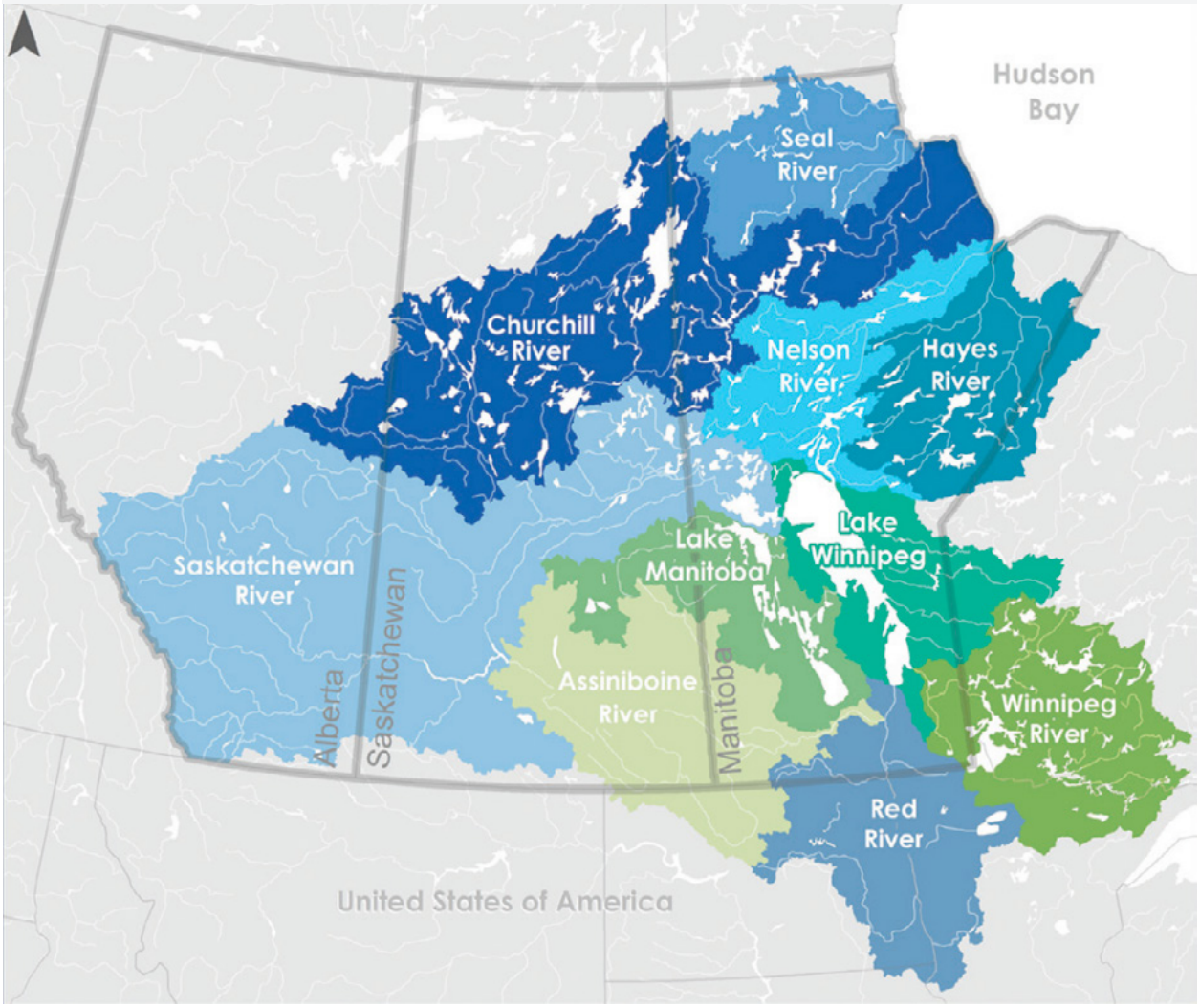
- Improved Livestock Manure and Mortalities Management Regulations
- Encouraged maintenance and establishment of on-farm water retention
- Developed and delivered federal-provincial National Water Supply Expansion Program (NWESP)
- Updates and revisions to Manitoba's Water Quality Standards, Objectives and Guidelines
- Established watershed districts as water planning authorities
- Amended Manitoba's Water Protection Act in 2015 to protect local ecosystems from non-native species
- Developed wetland and fish habitat classification systems
- Implemented mandatory certification process for operators of water and wastewater treatment plants
- Implemented Manitoba's Groundwater and Water Well Act (2012) to support and address well construction and capping
- Developed local drainage plans and upgraded drainage infrastructure in various locations across the province
- Tightened private sewer disposal standards
- Assisted Water Planning Authorities with development and implementation of Source Water Protection Plans
- Amended Water Rights Act to provide a mitigation framework for appropriate compensation for unavoidable wetland drainage
- Increased protected and conserved areas throughout Agro-Manitoba by more than 48,800 hectares
- Worked with watershed districts and agricultural producers to support small scale watershed and on-farm water retention projects
- Provided education, incentives and technical advice to landowners to support on-farm water retention projects
- Launched process to create new comprehensive provincial water conservation strategy
- Ensured adequate monitoring capabilities are in place to update and inform drought severity indicators, including Manitoba Drought Monitor website
- Led and facilitated the work of the Lake Friendly Stewards Alliance
- Developed Water Management and Structures Inventory
- Completed in 2020 an assessment of the current state of water supply/demand for both surface water and groundwater in agricultural regions
- Formed interdepartmental and interorganizational Manitoba Drought Assessment Committee, which meets twice per year
- Formed Interdepartmental Working Group for Water Supply Management in 2019
- Publishing monthly water availability and drought condition reports, including drought indicators for each major river basin

Recent Progress in Water Management Continued

The Sustainable Watersheds Bill, passed into law in June 2018, modernized four previous pieces of legislation related to water management. This included a new streamlined regulatory approach to drainage and water retention under the Water Rights Act to safeguard the benefits of wetlands through a "no net-loss" policy.[2] At the time it was estimated that Manitoba was losing over 2,000 hectares of wetlands a year — along with the social, economic and ecological benefits they provide — due to drainage and land alteration.[3]

The Province has also modernized the former Coservation Districts Program and is now implementing a new Watershed Districts Program that supports healthy and sustainable watersheds in Manitoba. Substantial new funding through the Conservation Trust and Growing Outcomes in Watersheds (GROW) trust are supporting change on the landscape through implementation of activities that create, conserve, or enhance natural infrastructure and nature-based solutions.

Major Drainage Basins Contributing to Manitoba



In August 2021, Manitoba also signed an agreement with the Government of Canada that sets out the Province's cooperative arrangement on Lake Winnipeg work for the next five years, with an option to extend for a further five years.[4]

Although the EAC notes that recent work by the Province and other local actors at the community and industry level supports a strong foundation for water management, the group recommends that "Manitoba now needs a comprehensive water management strategy that sets out the path forward outlining our goals and how we will meet them."

This has been given added urgency due to how circumstances have changed significantly even in just the past five years since the Climate and Green Plan was adopted.

Emergent Risks

Shifts in commodities markets toward more non-specialty crops and crops with longer growing seasons has increased demand among growers for irrigation. Without this added capacity, Manitoba growers risk a decrease in their economic competitiveness versus those in other jurisdictions — particularly Alberta and Saskatchewan, provinces which possess more robust irrigation networks.

Manitoba's lakes, rivers and streams, meanwhile, face challenges around growing concentrations of contaminants "of emerging concern", which consist of natural and synthetic substances such as pharmaceuticals, personal care products, endocrine disrupting compounds, organic pollutants, flame retardants and more, which current wastewater treatment methods are incapable of filtering out.[5]

Climate change has arrived much sooner and much more severely than most scientific models anticipated.

Weeks of relentless heat waves and record-low precipitation levels in 2021 throughout the spring and summer plunged Manitoba into its worst ever moisture deficits.[6][7] The Morden area had already experienced water shortages by early May and reverted to water restrictions by July. In total, 22 rural municipalities and six Northern Affairs Communities declared a state of agricultural disaster that same month.[8][9] Numerous other municipalities slipped into a potable water crisis by early August, with the RM of Macdonald at one point mere days away from running out of drinking water. The Government of Manitoba in November announced it was contributing nearly $6 million to support $18 million worth of water supply investment projects in Morden and the surrounding region to help provide some regional protection against future drought conditions, with most projects due for completion in 2022.[10]

Roseau River at Dominion City during drought conditions, August 2021. *Photo: Pembina Valley Water Cooperative*

Holiday Mountain Ski Resort in La Rivière announced on August 9 that it was cancelling its 2021-22 winter season due to the Pembina River, the resort's source to make man-made snow, running dry. It was the first time in its 60-year history that Holiday Mountain has had to cancel an entire season.[11]

These devastating drought conditions meant as well that ranchers contemplated having to either prematurely sell or cull their herds — or sell family-owned farms altogether — to cut their losses due to a lack of clean drinking water for livestock and barren land without enough grass cover for grazing.[12] Feed prices also spiked, requiring shipments of hay from out of province, while cattle prices were driven downwards.

The value of breeding cows at one point dropped by more than 50 percent, and market experts have forecasted price increases for beef through 2024 as a result of smaller herds than normal coming out of Summer 2021.[13] By August the province announced that it was investing $62 million into support programs to ensure that livestock owners could retain their herds in order to protect the long-term viability of the sector, which represents about one-third of Manitoba's $7 billion farm industry.[14]

A new study published in February 2021 examining the interplay between heat waves, climate change and economic output suggests that damages to agriculture from climate change may be 5-10 times greater than anticipated based on factoring in a lack of moisture alongside rising temperatures.[15] The latest global assessment by the United Nations' Intergovernmental Panel on Climate Change released in August 2021 confirms the continuation of significant planetary heating that the federal government's 2019 report, *Canada in a Changing Climate*, predicts will cause more frequent Prairie heatwaves, wildfires and droughts in the future.[16] [17]

Droughts and heatwaves tend to produce a negative feedback loop that places more stress on water supplies. Hotter temperatures and the presence of drought conditions creates higher water demand among agricultural producers, livestock owners and communities. At the same time surface water sources themselves lose volume due to evaporation, which — when combined with increased water usage — robs landscapes of vital moisture content necessary to moderate temperatures, and therefore prolongs drought.

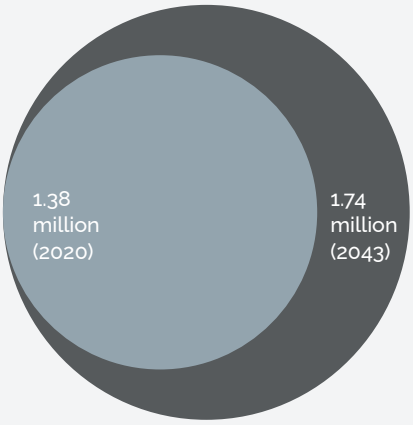
This can aggravate wildfires, which Manitoba experienced a three-decade high in 2021. Nearly 450 fires blazed across 1.2 million hectares, blanketing the province in record smoke levels and displacing over 4,000 people from seven First Nations and three northern communities.[18]

Droughts and heatwaves tend to produce a negative feedback loop that places more stress on water supplies as demand increases and surface water sources lose volume due to evaporation.

Energy prices also rose during this same period. Manitoba relies on hydropower for over 96 percent of its electricity and low levels of precipitation hinder Manitoba Hydro's ability to produce power, which in turn limits its ability to generate revenue through exports. The Crown corporation announced in November 2021 that lower provincial water levels over the previous summer were anticipated to have reduced its export revenue by $400 million for the year, leaving it with an expected deficit of around $200 million for 2021/2022. [19]

Milder winter temperatures and more summer drought may also impact the viability of some seasonal ice roads that are vital to bring goods to northern Manitoba communities. Climate change forecasts indicate this will be paired with a sharp increase in excess winter precipitation that could trigger more severe springtime flooding.[20]

Manitoba: Projected Population Growth, 2020-2043



Source: Statista

Flash flooding is more likely in the future too, similar to what happened in late August 2021 when the Government of Manitoba issued an overland flood warning for southwest Manitoba and parts of the Interlake region in anticipation of up to 120mm of rainfall in less than five days.[21] On August 21, Winnipeg was hit with over 65mm of precipitation in a 36-hour period, breaking the previous record of 47mm in 1983. Areas in southwest Manitoba including Brandon and Melita received over 70mm.[22]

A highway in the Red River Valley submerged by flood waters in April 2009. ***Photo: Jordan Morningstar/Flickr***

Both worsening springtime floods and more frequent flash flooding as a result of torrential downpours carry significant financial risk, and are something Manitoba should prepare for.

The cost of Manitoba's 2011 floods was estimated to be well over $1 billion, while the cost of the 1997 Red River flood was more than $700 million.[23] [24] A lack of action on mitigating flood damages will also invite lawsuits alleging provincial negligence and mishandling of what is now becoming a predictable climate threat. The 2011 floods, for example, triggered a $950-million class action lawsuit against the Government of Manitoba on behalf of 4,000 residents of four First Nations damaged by diverted flood water.[25]

A new flood prediction tool developed by an expert at Western University in Ontario has identified the Assiniboine and Red Rivers regions in Manitoba as some of the most at-risk areas in all of Canada for severe looding within the next 80 years.

According to media reports, the federal government says joint efforts with the provinces and territories to update flood mapping should be finished by the end of 2024.[26]

Beyond their immediate destruction and disruption,more frequent future floods also represent a secondary financial risk for Manitoba by being the extreme weather event most likely to trigger a credit rating downgrade if not adequately prepared for. A report by the Insurance Bureau of Canada (IBC) notes how Moody's Investors Service — the branch of financial services firm Moody's that deals with bond credit ratings — assesses climate credit risks for local governments based on four main factors: economic disruption, physical damage, population displacement and negative impacts on public health and safety. [ref27] IBC estimates that between 6-10 percent of Canadian homes are currently uninsurable due to flood risks, and suggests that number will rise as more insurance companies factor climate change into their risk assessment protocols.[28]

But as the Red River Floodway has shown, it is possible to greatly reduce the future impacts of flooding through decisive, forward-looking investment in protective infrastructure. Initially constructed between 1962 and 1968 at the cost of $63 million (the equivalent of $500 million today) before undergoing a $628 million expansion beginning in 2005 jointly funded by the Province and federal government. The floodway is credited with preventing tens of billions of dollars in damages to the city of Winnipeg and the surrounding area.[29] Some estimates place this amount at as much as $40 billion since 1968.[30]

An underappreciated risk to Manitoba's water supplies is a lack of political and legal certainty surrounding cross-boundary water flows.

In particular, the $1.2 billion Red River Valley Water Supply Project currently under construction in North Dakota. Once completed, the project aims to divert 0.7 percent of water flow from the Missouri River to central North Dakota and the Red River Valley to enhance the state's drought mitigation capacity in drier years. The Government of Manitoba has serious concerns with projects that would transfer water from the Missouri River to the Hudson Bay basin in North Dakota. These projects risk spreading harmful viruses, bacteria, and other invasive biota that could affect Manitoba's waters and freshwater fisheries.

The Boundary Waters Treaty was signed by Canada and the US in 1909, establishing the International Joint Commission (IJC) as a mechanism to prevent and solve transboundary water issues. The IJC's primary responsibility involves approving projects that affect water levels of cross-border lakes and rivers. The commission is also mandated to review and make recommendations on drinking water, commercial shipping, hydroelectric power generation, agriculture, ecosystem health, industry, fishing, recreational boating and shoreline property.[31]

Opportunities Exist

A good geographical location with a relatively large water supply, advances in food science, and expanding populations and emerging middle class markets around the world have opened up massive new agricultural and agri-food processing opportunities for Manitoba.

The United Nations' mid-line projection for global population growth over the next three decades shows the number of people worldwide expanding from 7.8 billion in 2020 to 9.7 billion in 2050.[32] The number of middle class consumers in emerging market countries seeking high-value food and protein options is also increasing rapidly. These two dynamics combined are forecasted to require total food production to increase by 60-70 percent by mid-century to meet future global demand.[33]

Global food supplies, meanwhile, will suffer in parallel from climate change, requiring increased production in viable regions — like Manitoba — to fill shortfalls. Warmer temperatures, changing rainfall patterns and more frequent drought across the globe will damage crops and make agriculture increasingly difficult in other more at-risk areas.

Combining growth in high-value crop production, crop science breakthroughs that boost yields and protect against drought, innovative livestock schemes and an expansion of agri-food processing could therefore position Manitoba to be a global leader in food exports, especially sustainable protein. High value crops, however, demand a water strategy that accounts for far more irrigation, as well as rapid drainage and widely-distributed, well-connected multifunctional water storage units. Hotter, drier summers due to climate change may also convince many more growers to newly irrigate crops out of economic necessity, further increasing demand for irrigation.

As of 2020, less than 1 percent of cropland in Manitoba was irrigated, some 40,000 hectares, compared to at least 137,500 hectares in Saskatchewan and 640,000 hectares in Alberta.[34]

Workers in southwest Manitoba sort potatoes during fall harvest in September 2016.
Photo: Brandy Saturley/Flickr

Both Alberta and Saskatchewan have also recently launched significant irrigation expansion programs. Already home to 70 percent of Canada's irrigated land, Alberta recently formalized an agreement with the Canadian Infrastructure Bank that will see the bank cover half the costs of an $815 million expansion of Alberta's irrigation system in the form of a 35-year loan, anticipated to create 500,000 new irrigated hectares.[35] Irrigation sales of high value crops and value-added processed food products in the province generate over seven times the revenue of traditional dryland crops. Alberta's irrigation industry contributes $3.6 billion per year to provincial GDP, and comprises 20 percent of Alberta's agri-food sector despite taking up less than five percent of the province's land area.

In July 2020, Saskatchewan's government announced its own three-phase, $4 billion irrigation expansion plan which aims to create over 200,000 new hectares of irrigated land using water from Lake Diefenbaker, doubling that province's current amount of irrigated space.[36] Saskatchewan also created its own provincial Water Security Agency in 2013 which is currently operating under the direction of a 25-year plan.[37]

An irrigation system waters alfalfa crops in British Columbia. Competing jurisdictions have recently outpaced Manitoba in expanding irrigation capacity. *Photo: Brad Smith/Flickr*

Manitoba has also become one of Canada's youngest and fastest growing provinces, with a population estimated to grow by several hundred thousand people to between 1.6 and 1.9 million residents in 20 years, reaching one million residents in the Winnipeg area.

The Winnipeg Metropolitan Region's *Plan20-to-50* — a 30-year integrated economic development strategy for Winnipeg and the 18 municipalities in the region that surround the city — has pointed to the area's ability to provide world-class quality of life, services, and productivity in which restoring and protecting water resources plays a large role.

According to a draft of the plan released in June 2021, more high-performing wastewater treatments are needed to foster vibrant communities, along with mixed land-use policies and watershed-based master planning to accommodate population growth and support the province's carbon emissions reduction goals.[38]

This could involve helping municipalities prepare drinking water and wastewater plans, increase water conservation through reducing demand and improving water recovery and recycling, and encourage service sharing between municipalities when infrastructure expansion and upgrades are required.

In November 2021, pointing to how "the population has grown beyond the capacity of existing infrastructure systems," then Central Services Minister Reg Helwer announced a combined $3.41 million in funding for upgrades to water treatment plants in both Morden and the municipality of Letellier.[39] That same month, Manitoba Premier Heather Stefanson and Winnipeg Mayor Brian Bowman jointly announced their intention to submit an application for funding for phase two of upgrades to the North End wastewater treatment plant as part of the federal government's Investing in Canada infrastructure program.[40] The City of Winnipeg's plan to reduce combined sewer overflows will cost $2.3 billion.

Adopting newly available and emerging technologies can help with this work by gathering better insights around issues and variables related to water supply and demand and discovery of new efficiencies.

Similar to the way intelligent technology is already being applied to digital agriculture, artificial intelligence and machine learning tools are being deployed around the world to enhance water management activities, from assessing water quality levels and urban water usage to pre-emptively identifying infrastructure maintenance needs years in advance.[41] [42] Flagging malfunctioning equipment before it breaks down and being able to prepare for droughts and floods months before they arrive would ensure that all three scenarios are much less costly and disruptive to businesses, industry, ecosystems and communities alike.

More powerful climate modeling is also paying dividends, particularly around wildfire and drought detection, two issues intimately tied to water management.[43] Indeed, without applying advanced technology to help solve the fundamental issues underpinning agriculture, industry and community development — which all tend to tie back to water use and the health of the surrounding environment — new policies and downstream interventions may be rendered ineffective.

The North End Water Pollution Control Centre in Winnipeg. Upgrading Manitoba's wastewater treatment capacities will be necessary to both accommodate population growth and meet water quality regulations, which will also protect the health and biodiversity of Manitoba's aquatic ecosystems.
Photos: City of Winnipeg (above), Flickr (below)

Here Manitoba is at an advantage by being able to learn from and apply best water management practices from other jurisdictions that have been grappling with water issues for a much longer time. Although launching a sector-by-sector analysis of water management needs and challenges throughout the province may be necessary first to provide a comprehensive baseline understanding of water issues unique to Manitoba.

Manitoba's existing challenges and opportunities around water give the Province the opportunity to be a leader in formulating answers to serious climate change dilemmas and economic development issues facing cities and regions around the world.

Water supply and demand, and water quality are all interlinked in complex economic, environmental and social ways. While the overall impacts of both climate change and economic development on water supply and demand are understood, the degree and speed to which they play out, and react to interventions, is not. Properly managing the variable water flows in and out of reservoirs, for example, requires assessing ever-changing commercial and community needs alongside local and regional environmental conditions, population growth, and income and behavioural changes within the province and surrounding jurisdictions, including water quality of inflows from outside the province and the efficacy of water measurement equipment.

Taken altogether, both Manitoba's existing challenges and opportunities around water give the Province the opportunity to be a leader in formulating answers to serious climate change dilemmas and economic development issues facing cities and regions around the world. Interviewed in August 2021, the executive director of the Prairie Climate Centre based at the University of Winnipeg said, "Manitoba is incredibly well placed to become a national and international climate leader."[44]

This is particularly true given Manitoba's hydropower potential, experience developing increasingly sustainable farming practices, and success through the Conservation Trust of promoting nature-based solutions like wetlands, marshes, and forests to mitigate the effects of extreme weather and promote sustainable communities.

Best Practices in Other Jurisdictions

The rise in drought conditions and more severe flooding due to worsening climate change has rendered water management an emergent issue in jurisdictions around the world. Authorities in some places, however, have been at the cutting edge of water management for years. Through their work they have been able to establish various effective methods and policies for securing freshwater supplies, expanding and optimizing irrigation use in agriculture, mitigating flood risks and adopting economic reforms that place a more accurate value on water resources.

The following section offers insights into water management programs and policies from four such jurisdictions – the Netherlands, California, North Dakota and Israel.

A satellite view of Zeeland, the westernmost province of the Netherlands.
Photo: European Space Agency/Flickr

The Netherlands: A realistic approach to climate adaptation

"We will need to adapt to what we cannot prevent; the urgency of climate adaptation is and remains of existential importance. We can no longer take it for granted that in the future, every area will have a sufficient supply of fresh water at any given moment."
- Delta Commission report 2020

As a densely populated and low-lying country of 17 million people, the Netherlands is particularly vulnerable to waterlogging and urban flooding. Launched in 2010, the Netherlands' Delta Programme is a strategic national approach to water management that has three main focus areas: improving flood risk management, securing freshwater supplies, and encouraging spatial adaptation to achieve both. The program is run by a Delta Commission that provides annual updates and suggested program revisions to the Dutch Ministry of Infrastructure and Water Management, under which the commission operates at arm's length.[45]

One of the Delta Programme's unique guiding principles – in contrast to the vast majority of climate action plans – is to front-load the cost and complexity of actions required to meet the program's strategic objectives by 2050. In later years, particularly after 2030, the intention is that the program's main focus will not be on new projects but on increasing the scope and scale of earlier measures, whose implementation and operation has become more predictable with time and practice.

Another novel recognition of the program, first highlighted in the Delta Commission's 2020 annual report, is that its future success depends on cybersecurity being considered a fundamental component of flood defense infrastructure amid the rise in extreme weather (and more recently, ransomware and cybercrime targeting critical infrastructure). Water utilities and IT facilities must be able to withstand heat, drought, and waterlogging to remain operational.

The program's $1.8 billion in annual funding is split roughly in half – 55 percent of annual funding goes toward new measures, with 45 percent used for administration, program management and maintenance of ongoing measures.

Flood risk mitigation

A subset of the overall Delta Programme, the Flood Protection Programme is renewed and updated annually by district water boards and the central government's public works agency for approval by the Dutch Minister of Infrastructure and Water Management.

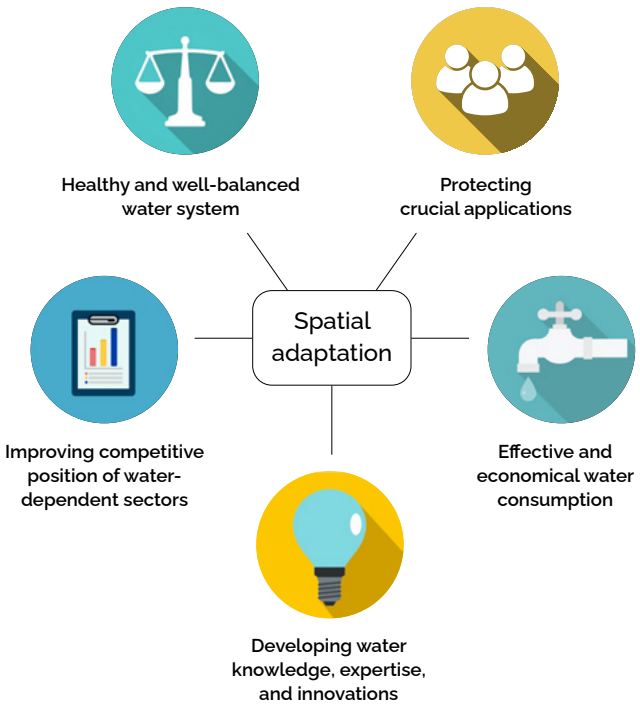
The underlying basis of the program is called a "flood probability approach", which mandates that even in future scenarios of extreme weather, flood risks ought to be mitigated to the extent that the individual risk of fatality from flooding in any given year is never greater than 1:100,000 (0.001 percent). Once this is achieved, additional flood protection measures are prioritized for areas that have a high population density, may generate the greatest amount of economic disruption if flooded, or where flooding could trigger the failure of critical infrastructure. This approach is credited with facilitating the institution of standardized levels of flood protection across the country. The policy has also provided the quantitative benchmark and three-step process necessary to accelerate investment into added protection measures by clearly identifying the areas of the country most at-risk of adverse flood impacts.

In areas where achieving flood protection measures through the construction of physical barriers (eg. dams or seawalls) would either be intrusive or prohibitively expensive, the required protection level may be attained through "smart combinations" that involve spatial planning and/or enhanced localized disaster management protocols. Approximately $15 million per year is allotted for flood protection innovations around physical design and integration, optimizing project approaches and tailoring flood protection measures to the capabilities and needs of local communities.

Protecting freshwater supplies

Another aspect of the Delta Programme's strategic goals is to ensure that freshwater demand will be shaped by, and reactive to the availability of water, acknowledging that in the future a sufficient supply of good-quality fresh water for every user and for every sector anytime and anywhere will likely be much less common than it is now.

To protect freshwater supplies, the program's policy platform recommends increasing the resiliency of the national water main system, improving freshwater infrastructure and retention efforts, and consciously anticipating a limited supply of freshwater in future decades as part of present day spatial planning. The latter recommendation highlights a prominent theme that runs through the entire Delta Programme – the open acceptance of latent risks that have become all but certain in a future of profound climate change. The intention is that being transparent with the public around water-related risks will enhance buy-in and resiliency efforts.



Consisting of three steps, the program's Water Availability Process helps clarify, track and improve the availability of freshwater under both normal and dry conditions in areas across the country. Authorities and stakeholders collaborate on mapping out freshwater supply and demand (further improving collaboration and transparency) and discuss means to optimize supply and demand. They then jointly create agreements on measures to be taken under both normal and dry conditions to protect freshwater supplies in a way that will prevent water shortages.

These agreements are typically built around three criteria, ranked in the preferred sequence of action – optimizing water use, improving water retention and achieving more efficient water distribution. In 2020, however, this was also expanded with a fourth step: creating a degree of societal acceptance of the damages that will occur as a result of climate change-induced water shortages that are virtually assured.

Spatial adaptation

The Delta Commission notes that the early arrival of more extreme weather due to climate change has elevated the importance of spatial planning initiatives to support the mitigation of flood risk and protection of fresh water supplies. Historically, water has not featured prominently into spatial planning in terms of land use and construction methods. This has left many sites, including pieces of critical infrastructure, such as power grids and hospitals, insufficiently protected from what will be increased waterlogging, heat, drought and flooding in the coming years.

The Commission suggests that attaining the Delta Programme's overall strategic goals hinges on water becoming a main pillar of spatial planning – "water steers, rather than water follows." This outcome is being sought through a mandated process whereby authorities every six years – or earlier, if events dictate – are tasked with analyzing local flood and water s hortage vulnerabilities, creating an adaptation strategy featuring specific goals, and embedding those ambitions into legislative and regulatory frameworks.

Delta Programme:
Spatial Adaptation Process and Objectives to 2050

By 2050, the Netherlands will be climate-proof and water-resilient

2020

Interim goals
With effect from 2020, climate-proof and water-resilient planning must be a standard element of all policies and actions

Every 6 years

Government authorities must periodically complete a cycle of:
Analysis - analysing vulnerabilities by conducting a stress test
Ambition - setting down an adaptation strategy based on a risk dialogue with partners
Action - embedding the strategy in implementation agendas, programmes, frameworks, legislation, and regulations

2022 2024

Provincial and municipal authories will embed climate-proof and water-resilient planning and implementation agendas in their Environmental Visions and Plans

2021 2023

By no later than the end of 2021, the central government will have conducted stress tests for all the national vital and vulnerable functions; by no later than the end of 2023, a realistic ambition will be set down in such formats as policies and supervision frameworks.

Ambitions regarding national vital and vulnerable functions

13 national vital and vulnerable functions

- Close collaboration between government authorities and providers
- The central government bears final responsabilities for the national vital and vulnerable functions. With respect to the construction of new vital infrastructure, local and regional governments play a key role in terms of spatial planning.

By 2050, the Netherlands will be more resilient against

Steps to render an area climate-proof and water-resilient

- Gaining a clear picture of vulnerabilities to extreme weather
- Drawing up a collective ambition
- Implementing ensuing actions
- Ensuring that daily and strategic actions are climate-proof and water-resilient (spatial planning, Water Review process)
- Ensuring that everyone is aware of and understands the residual risks
- Adapting calamity aid to residual risks; residents and businesses know what to do in the event of calamity
- Reviewing vulnerabilities every 6 years, as a minimum, and adapting as dictated by climate and spatial planning developments

California: Maximizing outcomes amid competing priorities

"Challenges that affect the State's ability to manage water resources for sustainability cannot be resolved with stopgap measures or by making minor adjustments. California's interconnected systems for using and managing water are extremely complex and subject to continually changing natural and human-made conditions." - *California Water Plan, Update 2018*

With a population of 38 million, an agricultural industry worth $50 billion per year, and home to three of the ten largest cities in America, if California were to be removed from the United States it would still be the world's fifth largest economy. The state also draws over 40 million visitors per year. All of this economic activity – further compounded by increasing climate change – puts tremendous strain on California's water resources, for which the state relies on its California Water Plan to sustainably manage and develop both now and into the future.[46]

California law requires that this strategic water plan, first enacted in 1957, is updated in five-year intervals by the California Department of Water Resources based on input from lawmakers, state agencies, resource managers, Indigenous groups, the private sector, academia and members of the public. The plan's most recent update was in 2018 and focused on funding goals and water investment strategies, as well as highlighting the need to strengthen efforts and initiatives at the local level to increase the state's overall sustainability.

And while the plan has undoubtedly enhanced the resiliency of California's water resources over the decades, evidence nonetheless shows the "vulnerability of the state's water resources is occurring in nearly all regions, and conflicts between ecological and human needs are increasing." This is especially true when considering that the "timing, quantity and location of precipitation in California are largely misaligned with agricultural and urban water uses."

Amid all of these challenges, which are only escalating year-on-year, the California Water Plan makes several strategic choices about where to focus efforts and resources to optimize positive outcomes for state water supply.

Aerial View of Sacramento River and plantation fields
Photo: Cassiohabib/Shuterstock

First and foremost is the commitment to continually improve integrated watershed management. This includes providing greater support for the role of nature-based solutions and natural infrastructure, offering more resources to local water management authorities, and harnessing floodwater for aquifer recharge while promoting sustainable levels of groundwater withdrawal. Two initiatives that are being taken to support this are greater facilitation of water management projects that have multiple beneficiaries, and undertaking attempts to properly quantify the value of the state's natural assets.

Many of these objectives align with another strategic goal: restoration of critical ecosystem functions. In broad terms, this involves addressing the negative environmental legacies of urban, industrial and agricultural development while also identifying and working to mitigate current and future conflicts between competing water management and natural resource use.

Given the complexity of water issues and multiple layers of legislation, policies and regulations affecting water use, the California Water Plan also emphasizes the need to improve alignment of water-related actions by different agencies at multiple levels of government. Two examples of successful outcomes of improved, inter-agency alignment are better incorporating ecosystem needs into water management infrastructure planning and implementation, as well as simplifying and streamlining the permit process for projects that can assist in environmental restoration projects.

The California Water Plan highlights the vital importance of information gathering and dissemination to support real-time decision making, adaptive management and long-term planning. This comes in many forms - from improved water monitoring and project performance tracking, to comprehensive water resource data collection, including the development of a regional water management atlas.

Expanding water resource education is also critical, including through more concerted effort to share information on how companies, county governments (municipalities) and communities can secure state and federal funding for their own water management activities.

Some 30 distinct water resource management strategies are made publicly available to help local agencies and governments manage their water and related resources.

The strategies provide techniques, policies and program proposals as solutions to everything from reducing water demand and increasing water supply, to improving flood management and enhancing water quality.[47]

Just prior to the release of the Plan's 2018 update, California's Governor Gavin Newsome directed state agencies responsible for natural resources, environmental protection, and food and agriculture to work alongside the state's department of finance to create a water resilience portfolio.[48] Released in July 2020, the portfolio consists of updates to government data and assessments of the impact of climate change on California's water network, including growing drought and flood risks, water supply/demand dynamics and water quality across the state, and projections of future water needs in coming decades for communities, economy and environment.

Water management in California underpins an agriculture sector that produces more than 400 commodities.
Photo: COLOMBO NICOLA/shutterstock

North Dakota: Project Planning

Given the complex ways that water supply and quality affects the local economy, society and environment, coherent and transparent project planning and eligibility criteria are fundamental to the success of any water management strategy. Stakeholders argue this is missing in Manitoba. The following shows the system that North Dakota's Department of Water Resources uses to ensure resources are efficiently allocated, and directed toward water projects that will have the greatest impact.

Essential Projects *(no priority ranking)*

- Agency operational expenses
- An imminent water supply loss to an existing multi-user system, an immediate flood or dam related threat to human life or primary residences, or emergency response efforts
- Existing agency debt obligations
- Regulatory projects

High Priority Projects

- Federally authorized water supply or flood control projects with a federal funding appropriation
- Federally authorized water supply or flood control projects that do not have a federal appropriation
- Corrects a lack of water supply for a group of water users or connects a city to a regional/rural system
- Corrects a violation of a primary water quality condition in a water supply system
- Addresses severe or anticipated water supply shortages for domestic use in a service area or city with rapid population growth
- Protects primary residences or businesses from flooding in population centers or involves flood recovery property acquisition

Moderate Priority Projects

- Dam safety repairs and emergency action plans
- Expansion of an existing water supply system
- Levee system accreditations, water retention, or flood protection property acquisitions
- Irrigation system construction
- New rural flood control projects
- Bank stabilization
- Snagging and clearing in population centers

Low Priority Projects

- Studies, reports, analyses, surveys, models, evaluations, mapping projects, or engineering designs
- Improvement or extraordinary maintenance of a water supply system
- Improvement or extraordinary maintenance of rural flood control projects
- Recreation projects
- Individual rural and farmstead ring dike constructions
- Snagging and clearing in sparsely populated areas

U.S. officials visit a water recycling wastewater treatment plant outside Tel Aviv. ***Photo: U.S. Embassy in Jerusalem/Flickr***

Israel: Overcoming water scarcity through innovation

"Israel is today one of the few countries in the world that has managed to almost entirely close the urban water cycle."
- World Bank analysis

Israel is arguably one of the most water-challenged nations in the world. The country of over 9 million people normally receives three quarters of its yearly precipitation in just three months, from December to February, with total annual water renewal barely eclipsing half of the 500 cubic metres per capita level defined by the United Nations as "absolute scarcity." Of Israel's rainfall, 25 percent is absorbed into the soil and five percent accumulates as surface water, while the remaining 70 percent is lost to evaporation given the country's warm Mediterranean climate.

It took several major droughts and an acute water crisis in 1998 to generate the political will to steer Israel away from a dependence on rainwater and pumping of groundwater to fill the gap, choices which only reduced water access during years of drought. Now, after many years of policy reforms and sustained public investment, the Israeli water sector is almost self-sustaining financially.

The only exception is wastewater reuse, which is subsidized by the government to improve water security. Otherwise user fees cover the bulk of water infrastructure investment and operating costs. The government, however, is still required to provide some support for water treatment sites, and management and maintenance of storage facilities

According to analysis by the World Bank, Israel is now home to one of the world's most innovative water sectors globally. "The country has had no choice but to adapt and gradually develop a series of water innovations in operational practices, technologies, and institutions," say the authors of a 2017 study.[49]

To manage water demand, policy reforms have been taken to improve residential water use, limit withdrawals of groundwater from aquifers, and shift water use in agriculture toward high-value irrigated crops to ensure that producers' incomes remain protected while achieving a simultaneous decline in water use.

A centre pivot irrigation system in Afula, Israel.
Photo: Heiner Shmitz/Water Alternatives Photos/Flickr

One of Israel's key innovations has been the ability to create infrastructure that enables treated wastewater to be used safely for crop irrigation and to refill depleted aquifers. According to the World Bank study, wastewater use meets more than 40 percent of the country's needs for irrigation, resulting in over 87 percent of wastewater being reused. High treatment standards allow for unrestricted irrigation of all types of agricultural crops without any risk to public health.

Some 400 artificial reservoirs have been built over the span of 30 years to store the reclaimed wastewater year-round for irrigation use in the summer growing season.

To encourage uptake of treated water by farmers for irrigation, authorities have allowed producers to convert their allocation of fresh water supplies to recycled water supplies at a 20 percent increase.

When water demand for irrigation is low, recycled wastewater is instead pumped into aquifers, which are utilized as tightly-monitored, multifunctional storage reservoirs. Natural water renewal has been boosted by 8 percent through building a combination of strategically placed retention walls and small dams, and launching programs of reforestation.

Freshwater supplies are mostly reserved for human consumption, industrial applications and ecosystem conservation. Major infrastructure investment over the past several decades has led to the creation of a water transfer system that carries 95 percent of the country's potable water resources to users, and is able to efficiently transfer water from areas of low demand to areas of high demand. (Israel's water strategy also relies on large-scale desalination to boost water supply, something not necessary available or feasible in other jurisdictions, including Manitoba.)

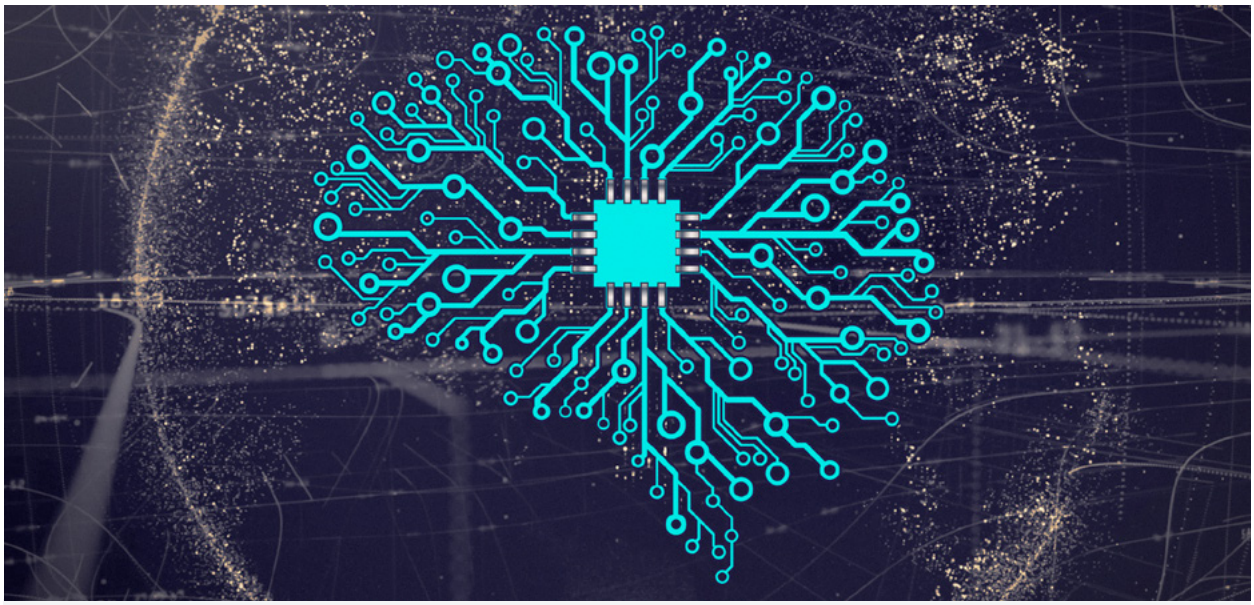
Since the mid-2000s Israel has also embraced the often controversial principle of pricing water as a commodity rather than providing it as a public good at heavily subsidized rates. This has included making market-based water pricing changes and implementing mandatory water metering for residential and commercial users. A caveat being that doing so has required diligent planning, well-thought out regulations and perpetual oversight to succeed. Over 15 years on, it is still a work in progress.

An 18-month, US$ 7.5 million public messaging campaign from 2008-2010 – during which water use fees were doubled – promoted the installation of water-saving devices in home kitchens and bathrooms, and involved media activities geared toward educating the public on the value of water pricing changes as a means to promote more efficient use and enable cost recovery for water supply networks and infrastructure. The combination of higher water fees and increased public awareness resulted in a 24 percent per capita reduction in urban water consumption.

The corporatization of water service providers has also been key – transforming them into private regional utilities that are financed through commercial partnerships and debt that isn't underwritten by the government. Likewise, the creation of an autonomous government agency, the Israel Water Authority (IWA), in 2007 has been an effective mechanism to ensure a long-term approach to water management.

Through establishing the IWA, Israel has been able to largely remove political interference from the management of its water resources, which were previously overseen by the agricultural ministry. Capital reserved for long-term, high-value investments in water-related infrastructure has also been more effectively sheltered from being appropriated for short-term political agendas of changing governments.

The IWA eventually absorbed and consolidated the responsibilities of all other regulatory bodies in Israel's water and sewage sectors, and now acts as a primary planner and regulator across the entire spectrum of water usage — from drinking water and sanitation, to irrigation and water resource management. Through its work, the agency still engages heavily with the ministries of agriculture, health, finance, environment and municipalities, although private contractors now perform a large portion of the tasks of Israel's water utilities. This ranges from operations and maintenance in water delivery networks to commercial services (meter installation, meter reading and billing, debt collection, call centers), supervisory control and data acquisition. Public-private partnerships have also been embraced as a means to finance infrastructure development throughout the country's water sector.



Enhancing water data collection and harnessing advanced technologies, like artificial intelligence, can lead to better decision-making processes around water management. *Image: vpnsrus.com*

Water Strategy Fund Projects

In May 2021, the Province of Manitoba provided EMILI with a grant to initiate and administer strategic projects that would support and inform the government's new provincial water management strategy.

An open, competitive-bid request for proposals was initiated in September 2021 based on three priority project concepts approved by the Water Strategy Fund Oversight Committee:

- Building a long-term, predictive water supply/demand tool powered by artificial intelligence (AI) and machine learning;
- A study detailing ways to improve water conservation and efficiency of water use in Manitoba; and
- An analysis of the potential return on investment of expanding provincial irrigation capacity.

After reviewing multiple proposals for each project, the committee selected leading global water engineering firm Stantec as the proponent for all three projects. They were launched in December 2021 and concluded in May 2022. Facilitated by EMILI, each project involved close collaboration between Stantec's team of experts and key senior staff members from the Government of Manitoba.

The following is a brief overview of the findings and outcomes of all three projects. Full detailed reports produced as part of each project's deliverables were submitted to the Government of Manitoba alongside EMILI's overall report at the end of May 2022.

a. Predictive AI Water Supply/Demand Tool

Water supply and demand are key elements of sustainability, and each is linked closely with economic, social and environmental aspects of Manitoba's development. The unique value provided by a cutting-edge AI predictive water tool would therefore be its ability to regularly evaluate medium and long-term water supply/demand for different geographic regions and sectors in Manitoba based on non-linear scenarios and multidimensional variables. Having this capability could assist with policy development, optimization of water use, and better management of water resources by decision makers at the provincial, municipal and watershed levels, as well as those in key industries.

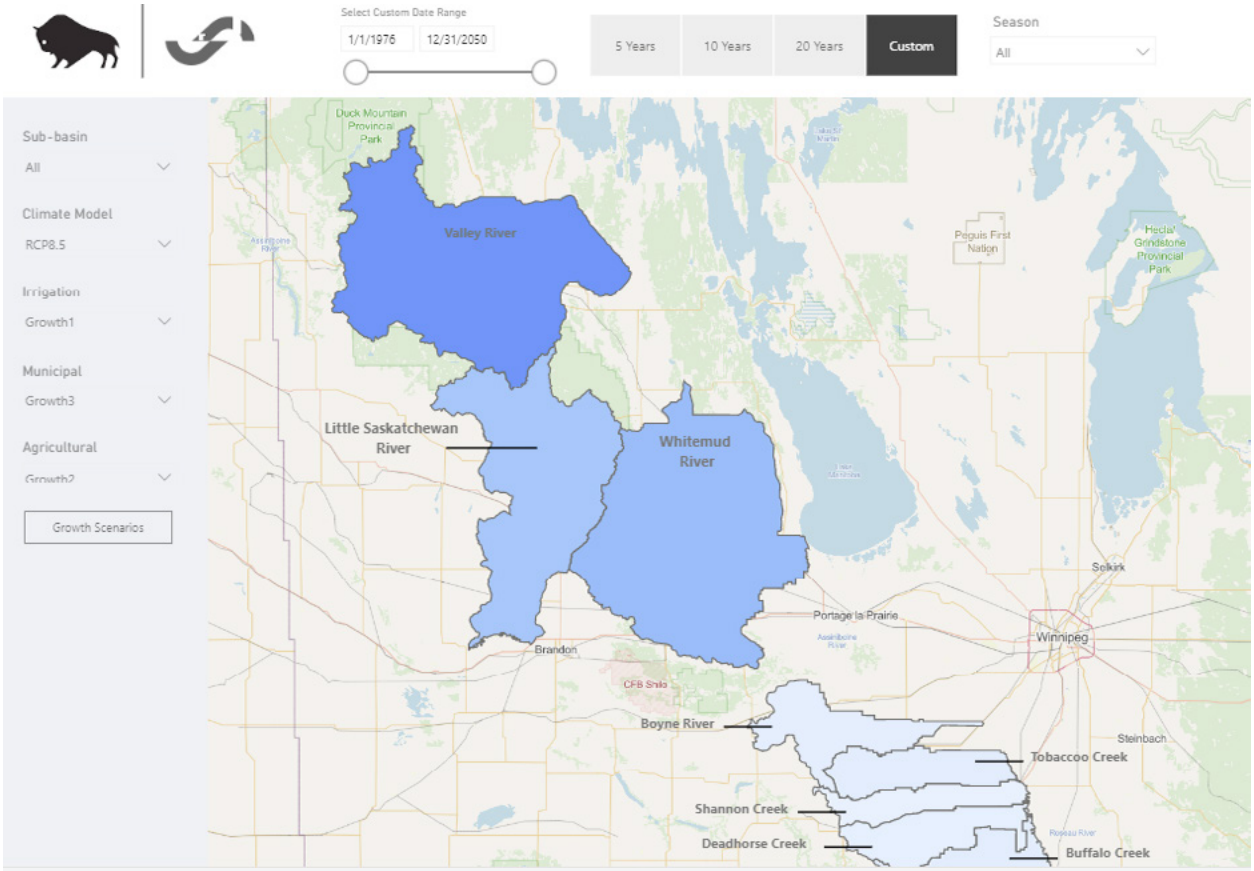
With this in mind, the aim of this project was to create a proof of concept tool that could forecast with a reasonable degree of confidence the available supply and demand of surface water within select Manitoba sub-basins in the future as the climate changes. The first iteration of this tool was delivered to the Government of Manitoba in May 2022, along with multiple options and recommendations for how to build out its capacities going forward.

Three different predictive models work synergistically within the delivered product. First, a purpose-built climate model – based on combining seven leading globally-recognized, state-of-the-art climate models – predicts how Manitoba will be affected by climate change over time across a range of climate variables. Second, the supply model uses these climate predictions to forecast future streamflow volumes and available water supply. Third, the demand model forecasts water demand from irrigation, municipal and agricultural (livestock watering) sectors.

The result is a tool that shows how changing projected trends in the climate affect total streamflow volumes and how much water could be required by different sectors under varying growth scenarios as applied to eight different sub-basins in Manitoba – Little Saskatchewan River, Buffalo Creek, Tobacco Creek, Whitemud River, Valley River, Boyne River, Shannon Creek, and Deadhorse Creek.

A user is able to choose between a "business as usual" climate scenario, which assumes that there are no significant social or legislative changes and carbon emissions continue the current trend, and an optimistic scenario, which assumes a major reduction in carbon emissions. The tool's forecasts extend to the year 2050 to align with other climate risk planning and mitigation initiatives already underway in Manitoba. Users are also able to select from various growth scenarios for each of the three mentioned demand sector models.

Forecasts from three models (climate, supply, demand) are then provided to the user through an interactive dashboard, with the understanding that the goal is to provide information that can help decision makers better understand the potential high level impacts and trends of climate change on surface water supply and demand – and not to precisely predict the exact volumes for each water sector/user in the chosen chosen region. Weather is random and is therefore impossible to predict exactly this far into the future.



A screenshot of the mapping and scenario selection page within the predictive AI-powered water supply/demand tool delivered to the Government of Manitoba in May 2022.

Several provincial data gaps were identified while building the tool:

- The Government of Manitoba should improve its ability to monitor and understand the difference between licensed water volumes and actual levels of water use by license holders. The government has already begun some of this work through the development of a digital database of water use licensing information, including water use records. Having this additional data, plus digitizing historical hardcopy records and integrating those into the database, would enable the tool to enhance its water demand modeling in the future.

- The model underpinning the water supply forecasts produced by the tool relies on historical stream volumes to model physical soil parameters. Collecting streamflow volumes over time for any streams within the highlighted sub-basins not modeled in the proof of concept tool – most of them smaller streams – would allow those streams to be included in future versions of the tool, broadening its geographic scope.

- The tool's precision and utility would greatly benefit from additional information about municipal water demand, including seasonal or month-to-month changes in water use, along with more details around what applications water is used for. Some of this information may already be available from other departments within the Manitoba government or directly from municipalities or water co-operatives. Better understanding and documentation of this information would allow for more detailed and accurate water demand modeling.

- The scope of this project was limited to surface water supply and demand forecasting, but much of the water used in Manitoba comes from groundwater sources. To completely model the impact of climate change on water supply and demand, groundwater must be accounted for. There is already groundwater monitoring in place for major aquifers in Manitoba but this does not cover all groundwater sources.

Recommendations to increase the tool's effectiveness include:

- Enhance the dashboard for a more user-friendly experience | The current dashboard has all forecast information generated by the models, but it may not be displayed in the best possible way for all users.

- Expand modeling to additional sub-basins | The forecasts in the current version of the tool apply only to the eight sub-basins previously mentioned.

- Update models in the future with new data | The background modeling done to produce the tool's water supply/demand projections are based on data sets that were taken at a snapshot in time and will become less relevant over time. A technical memorandum provided by Stantec along with the delivery of the tool recommends updating data every 1-3 years, which is long enough for new climate model information to be released and more historical streamflow volumes to accumulate.

- Extend model to include groundwater supply and demand | As mentioned, groundwater data is limited in certain areas of Manitoba and groundwater modeling was outside the scope of this project. Yet groundwater modeling is needed to be able to draw better conclusions about supply and demand of the entire water system in the province.

- Improve municipal water demand modeling | Municipal water demand was forecast in a limited way in this project. Municipal water is the sector which accounts for the second greatest water volume licensed in the province (after irrigation).

- Integrate information from the tool into the water licensing process | One of the goals of this project was to indirectly aid in the approval process for water licensing. By allowing government staff to see how water licenses approved today may affect water supply/demand scenarios in the future as the climate changes, it could improve the Province's overall decision-making process around water licensing. Custom dashboards and outputs could be specifically created for this purpose.

Based on a study commissioned by EMILI, Manitoba has enough yearly surface water to potentially support around 1.5 million irrigated acres of land. *Photo: United Soybean Board*

b. Study: Return on Investment in Irrigation Expansion in Manitoba

As climate change increases the amount of extreme weather and moisture variability in any given year, bolstering provincial irrigation capacity will be vital to help expand Manitoba's agriculture and agri-food industries, while also offsetting drought conditions. Yet building this added capacity will require a long-term strategy and sizable investment.

To help inform the Province of the possible role(s) irrigation can play within a new water management strategy – and how governments at all levels can achieve its goals in the most cost-effective way – EMILI commissioned Stantec to deliver a report providing findings and recommendations from a comprehensive study on the potential rate of economic return on irrigation development and conversion of dryland acres to irrigated agriculture.

The study took a holistic approach in identifying opportunities for dryland conversion and expansion of irrigated agriculture in watersheds where such an expansion was determined to be an efficient use of potentially available water supply and resources. Part of this was done by looking at suitability of soils for potato production as well as other crops grown in rotation, best practices that have proven successful in other provinces to expand irrigated agriculture and provide optimum water conservation, as well as providing a high-level assessment of potential water capture opportunities within major basins based on data provided by the departments of Manitoba Agriculture and Environment, Climate and Parks. The study also provided estimates for the range of growers' ability to pay for project development under three different irrigation farming scenarios, while also highlighting other potential funding sources for irrigation development projects.

Analysis of data to provide a novel quantification of water volumes in relation to long-term ecosystem considerations was not part of this study, in recognition that existing Government of Manitoba policies enable protection of instream flows when allocating surface waters for human needs. However, the study does note that as the amount of irrigated lands increase, the Government of Manitoba should conduct additional analysis around the efficacy of its existing instream flow policies, as well as increase monitoring and enforcement efforts to ensure that the current policies will protect future instream flows adequately while providing opportunity for future increases in irrigated acreage.

Based on planning, design and construction experiences in Alberta and Saskatchewan, the study recommends that the Government of Manitoba ensure that future planning, design and construction for all irrigation projects in the province should require sprinkler or drip irrigation systems for the field application and pipeline distribution systems from the diversion point or water holding facility. The water holding facility should be lined or sealed to assure minimum water loss during the storage season. Moreover, consideration should be given to include multi-use project(s) to allow optimization of available provincial dollars to minimize the impacts of flooding and potentially capture water that could be used for irrigation development and/or multi-use projects.

A review of available information provided by the Government also showed that several watersheds of the province have a total annual average of approximately 750,000 acre-feet of remaining surface water available for human allocation across the Assiniboine River, Red River, Lake Manitoba, Lake Winnipeg, Souris River and Whitemouth River basins. Assuming this water is highly reliable – i.e. available every year – the water could potentially support up to 1,525,626 irrigated acres. (Note: the allocation of water in water-short years should be included in future studies.) Key budgeted aquifers in southern Manitoba – such as the Assiniboine Delta Aquifer, Winkler Aquifer and the Oak Lake Aquifer – all have assessed sustainable yields associated with them as well, but most are fully allocated at this time. However, in some instances, information on sustainable yields has not been updated for over three decades.

Additional reassessments of sustainable yields for all budgeted groundwater aquifers may allow Manitoba to make additional allocations of groundwater from these sources in the future, provided the assessments concluded it was safe to do so from a long-term sustainability perspective. (As of May 2022 there is an ongoing study being led by the University of Manitoba to update the sustainable yield for the Assiniboine Delta Aquifer, which is a major source for irrigation water supply.) According to Stantec's analysis, there are non-budgeted aquifers that should be considered for use in irrigation development as well: "It would be in the best long-term interest of Manitoba to develop baseline groundwater conditions of each of the aquifers within the province and determine the safe sustainable yield of those aquifers that have the highest probability of future development."

Based on the study's findings, Table R1 summarizes the potential range of annual direct (on-farm) and regional impacts per-acre that might accrue due to an investment in irrigation. These direct benefits represent the incremental, on-farm income for each of the three crop rotation scenarios considered in the study. In addition to the direct on-farm benefits, the region would also benefit from an increase in gross domestic product (GDP), and full-time equivalent (FTE jobs) which is estimated to increase from $1,115 per acre to $2,594 per acre. In other words, for every additional dollar of on-farm production the regional GDP increases between $0.72 and $0.87. Additionally, the investment in irrigation produces between 4.5 full-time equivalent (FTE) jobs to 13.8 FTE for every additional $1 million of on-farm production.

Table R1: Total Estimated Annual Economic Benefit per Acre from an Investment in Irrigation

		Scenario		
		Scenario 1: Selectively Irrigated Vegetable Rotation A 3-crop rotation: vegetable (potato), oilseed (canola), and cereal (wheat); only the vegetable (potato) is irrigated	**Scenario 2: Entirely Irrigated Vegetable Rotation** Same rotation as Scenario 1, but all three crops are irrigated.	**Scenario 3: Entirely Irrigated Non-Vegetable Rotation** A 4-crop rotation, all irrigated: an oilseed (canola), two cereals (wheat, oats), and a specialty crop (soybeans)
Direct Impact	Production*	$1,584	$2,988	$1,946
Regional Impact	GDP increase	$1,155 - $1,375	$2,178 - $2,594	$1,418 - $1,689
	Labour Income	$437 - $740	$824 - $1,397	$537 - $909
	Employment (FTE)	0.01 -0.03	0.02 - 0.06	0.01 - 0.04

**Direct on-farm production may range +20% or -20% depending on the range in yield and crop prices. Yield may fall for a variety of reasons, including weather, soils classification, cultural practices, etc.*

Hypothetical Investment Scenarios

Based on the per acre benefit model presented above, the study also estimated a range of both the marginal profits and the hypothetical contributions to an investment in irrigation that may be available under different hypothetical scenarios about crop rotation and irrigation intensity:

- Scale A is the single-farm scale, where the hypothetical investment in irrigation ranges between $210,000 and $719,048. Scale A might be achieved if Manitoba offered subsidy and/or low and no-interest revolving loans to growers. The subsidy, or favorable loan terms would reflect the regional economic impact benefit that Manitoba receives, so that both the beneficiaries (e.g. the growers and Manitoba) are paying.
- Scale B assumes that enough acres would be planted in potatoes to provide the local processing plant an additional 10% of production. This 10% was identified as the percentage of product that had to be imported from outside Manitoba to maintain full production capacity at the processing plant. Under that assumption the hypothetical investment ranges between $1.89 million and $6.47 million.
- Scale C assumes that roughly 5% of the potential surface water supply available for licensing is used for irrigation. In this case the hypothetical investment ranges between $29.0 million and $35.51 million.

Table R2: Estimated Farm-Level Hypothetical Investment Required to Achieve Annual Economic Benefits (Table R1)		**Scenario 1: Selectively Irrigated Vegetable Rotation**	**Scenario 2: Entirely Irrigated Vegetable Rotation**	**Scenario 3: Entirely Irrigated Non-Vegetable Rotation**
Per acre	Marginal Profit	$280	$958	$938
	Hypothetical buy-in %	50%	50%	50%
	Hypothetical Investment	$140	$479	$469
	Variance with yield	+/- $158	+/- $483	+/- 449
Scale A Single Farm	Hypothetical Investment	$210,000	$719,048	$703,487
	Variance with yield	+/- $237,491	+/- $724,124	+/- $674,192
Scale B Potato Production Shortfall	Hypothetical Investment	$1.89 million	$6.47 million	
	Variance with yield	+/- $2.14 million	+/- $6.52 million	
Scale B Potato Production Shortfall	Hypothetical Investment	$35.51 million	$31.20 million	$29.00 million
	Variance with yield	+/- $40.16 million	+/- $31.42 million	+/- $27.79 million

The information presented in Table R2 utilized the "beneficiary pays" concept for irrigation projects. One other potential beneficiary and/or source of funding may come from the Government of Canada, given how the regional economic impacts of expanding irrigation in Manitoba may generate benefits that accrue to the country as a whole. By extending the beneficiary pays principle, it seems plausible to consider the federal government as a potential funding source.

Some key recommendations identified by the study to help the Province achieve its goals around irrigation expansion include the following:

- The Province's future planning processes and economic analysis of irrigation expansion could benefit from having more data – in particular, increased GIS coverage of currently irrigated lands and estimates of the change in crop yield of various crops when switching from dryland to irrigated acreage, including how sensitive crop yield is to various soil classifications.

- Gather additional data and conduct further evaluation of available water supply, reliability of that supply, and projected flooding would allow the optimum number of acres to be considered for surface water licensing.

- Follow through with the development of the new provincial water management strategy and integrate it into the next Manitoba Water Rights Act and other relevant legislation.

- Make improvements to current government databases – for example, data on number of crop acres currently irrigated, what crop was grown and whether irrigation supplies were groundwater or surface water was not readily available. An investment in improving resource databases may yield large returns in future planning and modeling efforts.

- The Manitoba Agricultural Services Corporation (MASC) database provides yield information by risk areas with a separate insurance pool for irrigated processing potatoes – consideration should be given to creating a separate insurance pool for other irrigated crops.

- Make educational programs and technical information available for unique equipment requirements, equipment availability and financial considerations for specialized equipment required to expand irrigated potato acres compared to other crops.

- Drainage of lands proposed for irrigation is a key component of successful conversion from dryland to irrigated agriculture; additional studies are required to identify potentially impacted lands and drainage plans to mitigate the drainage impacts.

- Developing irrigation water supplies for agriculture may return large benefits early on, however at some point in time the marginal benefit of allocating more water to agriculture may begin to diminish. Creating a plan to understand when that point of diminishing returns is reached is part of a robust, resilient water management plan.

- Consider non-structural solutions (i.e. those that don't require infrastructure investment) as complementary initiatives to support irrigation expansion, including conjunctive use, water markets during periods of drought and even revolving loan programs for field or farm-level irrigation improvements -- especially when considering the gradual diminishing marginal returns as irrigated crop rotations expand into lower-yield lands and the prioritization of irrigation supplies in water-short years.

- Consider hydrogeological studies for additional groundwater aquifers to determine the amount of water that could be made available for irrigation development and other multi-purpose development.

- Consider exploring multi-use water projects that assist in allocating water across many uses and potentially multiple benefits, including irrigation. A multi-use project that embraces the concepts of cost-sharing and beneficiary pays may prove to be an efficient tool for resilient water management. All stakeholders should be well aware of proposed multi-use water projects and invited to participate in preliminary and planning activities to avoid conflicts.

c. Study: Improving Water Conservation and Efficiency in Manitoba

The objective of this study was to provide the Government of Manitoba with recommended strategies and tactics to achieve greater water conservation and water use efficiency across different sectors in Manitoba, based on developing a better evidence-based understanding of the context of provincial water use and adopting relevant elements of proven best practices from other jurisdictions. This included compiling key performance indicators that should be monitored, provincial programs that should be implemented, and communication, education and outreach techniques that should be used to teach the importance of water conservation and water use efficiency.

As part of this process, Stantec conducted case study interviews with leading municipal and agricultural water providers and thought leaders in Manitoba, Western Canada, and the Western United States to collect information on their approach to planning for water conservation, water efficiency and climate resilience.

The study identified a total of 20 potential areas of improvement for water conservation and water efficiency practices and programs in Manitoba based on best practices, and developed a total of 77 recommendations. This includes 58 recommendations for water users, water providers and the Government of Manitoba on water conservation and efficiency improvements, and 19 suggested water conservation and efficiency public information campaign strategies for water providers and the Government of Manitoba.

Lastly, 26 key performance indicators (KPIs) were developed related to water supply and water demand that, when monitored over time, will help water users, water providers and the Government of Manitoba to assess success of water conservation and efficiency efforts and to make important operational or planning decisions.

Homes under construction in October 2019 on Marcel Colomb First Nation (Black Sturgeon), 320 kilometres northwest of Thompson. The Stantec Conservation and Efficiency study recommends increasing the available funding and access to funding for Northern communities for water distribution system operations and maintenance. *Photo: Ph Gorzen/Wikimedia Commons*

A thoughtful consideration of water conservation and efficiency will undoubtedly be an important component of Manitoba's new provincial water strategy. But the study makes clear that when it comes to water conservation, there is no "one size fits all" approach – solutions and goals must be tailored to each community's unique needs and opportunities. As such, all of the recommendations provided in the study will not be applicable to all water providers and all water users in Manitoba in all circumstances. However, implementing some or all of the appropriate recommendations would go a long way in improving water conservation and efficiency in Manitoba, and thus help to manage water more sustainably in the face of a changing climate and growing economic and social needs.

The following table highlights some of the specific novel recommendations from the study – suggestions not similarly heard through stakeholder engagement – for consideration by the Government of Manitoba, as well as provincial water providers and water users.

Recommendation	Water Users	Water Providers	Govt of MB
Evaluate decreasing the magnitude of the "domestic exemption", where Manitoba users are not required to obtain a license for water withdrawals amounting to less than 25,000 litres per day			✓
Target commercial users with large water losses (e.g., hotels, restaurants) to undergo a water audit and perform maintenance to fix leaks		✓	
When installing, repairing, or replacing water pipes in distribution systems, ensure that there is skilled, experienced construction oversight to make sure that work is performed in accordance with applicable specifications and standards		✓	
Phase-out water inefficient fixtures, appliances, and equipment where appropriate; can be done using passive or active measures – e.g. updated codes or rebates	✓	✓	✓
Define minimum water conservation standards for building construction and renovation that meets or exceeds national standards		✓	✓
Ensure that source waters are protected to prevent increased treatment costs or prevent water waste if there is a contamination issue		✓	✓
Develop and make available a model water conservation plan for customization by and use of water providers			✓
Encourage or require water providers to develop drought contingency plans and municipalities and rural municipalities to institute drought restriction bylaws		✓	✓
Increase the available funding and access to funding for Northern communities, such as through Indigenous Reconciliation and Northern Relations, for distribution system operations and maintenance			✓
Include tracking and reporting on system leaks as a water license requirement			✓
Improve access to guidance and training for water system operators, especially in smaller or more remote communities			✓

Recommendation	Water Users	Water Providers	Govt of MB
Look at ways to decouple water licensing from water use, allowing farmers flexibility to utilize conserved water as they see fit, such as through increasing flexibility regarding irrigated acreage or crop types; this could include varying the price of a license as a tool to incentivize water use reductions			✓
Leverage the Government of Manitoba's promotional partnership in the EPA WaterSense program and share relevant information and activities with water providers and water users			✓
Explore mechanisms for dedicated funding streams for water programs and projects – e.g., specialized license plates, lottery revenue, hunting and fishing licenses, soft drinks, dedicated water sales tax			✓
Investigate mechanism for license holders to sell surplus water – i.e., water markets			✓
Establish a leak detection program/mechanism	✓	✓	✓
Mandate the use of meters for water users, as appropriate		✓	✓
Implement policies to increase water use reporting compliance by licensed users and irrigators, such as through annual renewal requirements or other incentives or penalties			✓
Water providers should take part in national benchmarking initiatives to ensure that data are collected and metrics are calculated using standardized methods		✓	
Conduct a provincial water census, based on U.S. Geological Survey's National Water Census approach, at a recurring interval – e.g. every 5-10 years			✓
Encourage local media coverage of water conservation issues and the importance of water conservation, especially during dry years		✓	✓
Include educational signage and materials in public and publicly-funded buildings highlighting the water saving measures and the water saved			✓
Implement a province-wide "Water Leaders" program to increase relationship building and knowledge sharing across professionals in the water industry			✓
Create more detailed but easy to understand water bills that show customers their usage and associated charges. Bills should include tips on conservation and comparisons to previous bills – e.g. prior 12 months, on a rolling basis		✓	
Make government and water provider staff available to give presentations and/or workshops on the importance of water conservation and ways to save water to local organizations, schools, and civil society groups		✓	✓
Tailor messages to resonate with the water users and specific industries – e.g. by recognizing the values and needs of the target audience and producing materials in multiple languages		✓	✓

Key Stakeholder Interviews

From September 2021 to March 2022, staff and representatives from 34 key stakeholder organizations across four theme areas were interviewed for their insights into water management issues in Manitoba. Their feedback has been compiled and arranged according to the eleven focus areas of the Province's draft water strategy framework.

Participants were granted anonymity of their comments to allow for candid responses, which have been edited for length and clarity.

The opinions and perspectives expressed by stakeholders are subjective, and reflect participants' current and/or historical experience with water issues in Manitoba. They do not necessarily reflect the views of the Oversight Committee.

List of interviewees

Agriculture & Agri-Food Processing

- Jeff Vassart, President, Cargill Ltd. (MB)
- Pamela Kolochuk, CEO, Peak of the Market
- Dan Sawatzky, General Manager, Keystone Potato Producers' Association
- Michelle Finley, Communications and Public Affairs Manager, Roquette
- Dan Parynuik, Raw Procurement Manager;
  Scott Graham, Agronomy Raw Development Manager, Simplot
- Sheldon Stott, Senior Director of Corporate Sustainability, Hylife
- Dan Heaney, Senior Agronomist, Farmers Edge
- Bob Mazer, President and CEO, Mazergroup
- Carson Callum, General Manager; Maureen Cousins, Policy Analyst, Manitoba Beef Producers
- Brent VanKoughnet, Owner/Manager, Agri-Skills
- Various Board Members of Dairy Farmers of MB
- Local Manitoba Plant Manager, Bunge North America
- Jason Gould, Director; Dan Bouillon, Chief Financial Officer; and Christianne Rosset, Plant Manager, NutriPea
- Munish Sharma, Maintenance and Engineering Manager (Brandon); and Tricia Schmalenberg, Environment Manager, Maple Leaf Foods

Environment & Ecological Services

- Mohammad Ghoreishi, Hydrologist, Global Institute for Water Security (Univ. of Saskatchewan)
- Murray Taylor, Member of MB Business Council Integrated Water Strategy Committee
- Stephanie Cairns, Director (Circular Economy), Smart Prosperity Institute
- Dr. Alex Koiter, Associate Professor (Geography and Environment), Brandon University
- Alexis Kanu, Executive Director, Lake Winnipeg Foundation
- Tracy Maconachie, Provincial Policy Specialist (Manitoba), Ducks Unlimited Canada
- Daniel Gladu Kanu, Director, Lake Winnipeg Indigenous Collective

Infrastructure & Resilience

- Dave Morgan, North American Technical Lead (Water Resources in Environmental Services), Stantec
- Sean Barnes, Corporate Vice-President (Special Projects), PCL Construction
- Lynda Nicol, Executive Director, Manitoba Association of Watersheds
- Travis Parsons, General Manager, Manitoba Water Services Board
- Kristina Koenig, Hydrologic and Hydroclimatic Studies Section Head; Michael Vieira, Hydroclimactic Studies Engineer; Mark Reed, Regulatory Coordination Officer, Manitoba Hydro
- Hank Venema, CEO, Strategic Systems Engineering

Community & Economic Growth

- Chuck Davidson, President, Manitoba Chambers of Commerce
- Denys Volkov, Executive Director; Stefanie Vieira, Senior Policy Analyst, Association of Manitoba Municipalities
- Derek Earl, Vice President, World Trade Center Winnipeg
- Bill Ashton, Director, Rural Development Institute (Brandon University)
- Greg Archibald, CEO, Pembina Valley Water Co-operative
- Dean Schinkel, Office Managing Partner (Winnipeg); Anita Shinde, Partner - Economic Advisory;
  Trevin Stratton, Economic Advisory Leader; Matthew Stewart, Director of Financial Analysis, Deloitte
- Steve Strang, Manitoba Director; Ted Preister, Executive Director, Red River Basin Commission

Focus 1

Enhance water supply for sustainable development

- "People just don't recognize the economic opportunity Manitoba has around secondary processing of agricultural products. All this stuff is going through Emerson into the States and being processed at the secondary level down there, because we aren't providing more water supply to process it here. People just don't understand the opportunity — it's all just: No, we haven't figured out the funding."

- "For primary agriculture, as the value of commodities keeps increasing, the consistency of crop output is going to become a much greater requirement for contracts. And access to irrigation water is something that's gonna become a greater demand. So much so that it might come to be considered almost a prerequisite for growers entering crop contracts with big companies who are going to want that consistency of supply."

- "Some producers, we've just run out of the ability to expand currently. The capacity for water availability for irrigation is pretty much maximised here. There's only so much that can be done on the efficiency side. Manitoba being one of the later jurisdictions to adopt or expand irrigation, we're already using some of the latest and most efficient technology and water delivery systems."

- "It's not that we're looking to grow exponentially as a company, rather having reliable and reliably adequate supplies of water is about mitigating risk. Right now we have a single source water supply, and for us there's an element of risk that comes along with that. If something should happen to that water supply, what are our options and opportunities?"

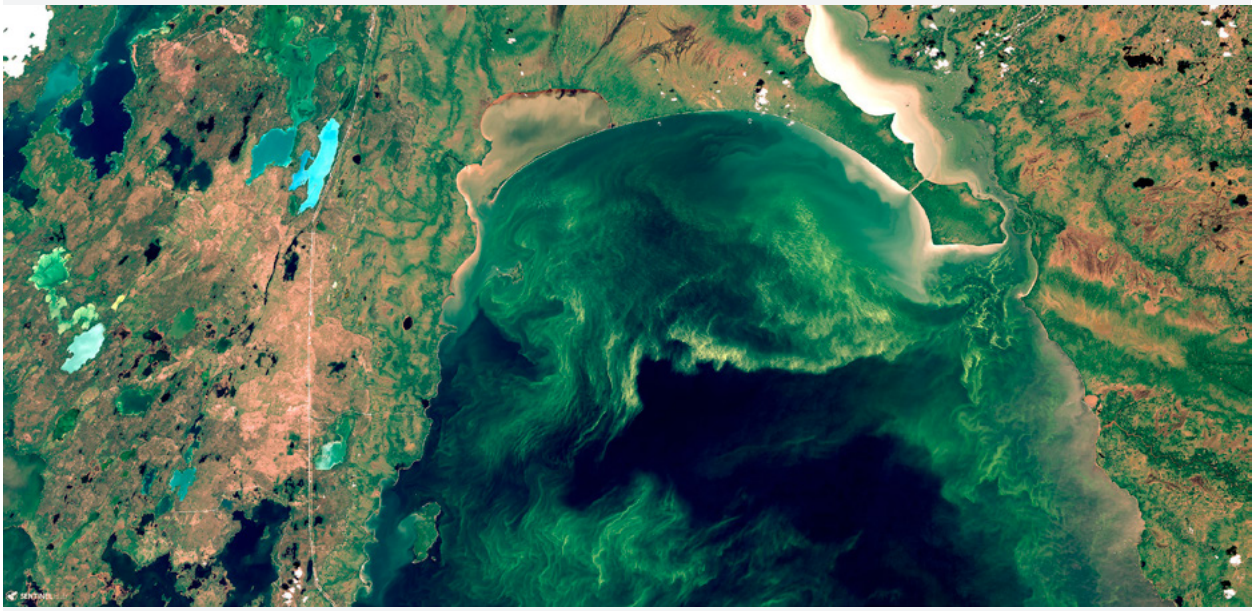
- "Any new water strategy has to have scientific backing, with an understanding of the water resources that are there, and their availability into the future. That's paramount. With the uncertainty of it all, you also have to go forward with a sense of caution, and perhaps even a little bit of protectionism. I think we take water a little bit for granted in this country, and we have to be a little more cautious in how we allocate our supplies."

- "The continued promotion and subsidization of drainage and land clearing makes the expectation to protect water resources a challenge, because obviously those can run counter to one another. There's also concerns that land productivity is prioritized over everything else. So the challenge sometimes comes in terms of mindset, and the need to change those sorts of things."

- "Manitoba's water resources can be used as a competitive advantage, but again, that has to be done in a sustainable manner as well. We can't have four or five McCain's and Roquettes all in a confined area and be able to meet the needs of those companies and meet the needs of the communities that are surrounding it. It's not just about the here and now, but asking what it's going to look like 5, 10, 20 years from now, and what other businesses will be attracted to be near these businesses – and how can we accommodate secondary growth?"

- "Generally we think of upgrading irrigation systems as a way to decrease water demand, but the opposite seems to be true when you see how it plays out over multiple decades, rather than months or years. Irrigation systems allow us to save water, but at the same time this often motivates producers to maximize their own personal economic benefit by increasing their production by expanding irrigation, thereby increasing overall aggregate water demand. In order to preserve water savings achieved through irrigation, that new technology has to be introduced with a willingness to gradually restrict water usage into the future. That way the water savings produced by the new technology is not just lost by water savings being applied somewhere else. If we really want to save water for environmental purposes, there needs to be some sort of science-based cap on water."

Photo: Mark Stebnicki/Pexels



A satellite view of algae blooms at the northern edge of Lake Winnipeg, August 2017. Nutrient build-up in the province's largest water body due to agricultural run-off, including in upstream jurisdictions in the U.S., is producing water quality concerns for Manitoba. *Photo: Sentinel Hub/Flickr*

- "As much as policy makers focus on water supplies and infrastructure and those things, they also need to pay attention to the changing behaviour of humans and how that plays a very important role in water management. This is something that is unpredictable and which even sophisticated modelling tools cannot fully capture."

- "The infrastructure needed to support wet industries, especially those agriculture-related, are significant and can only occur in certain areas of Manitoba. Municipal governments should not be responsible for paying entirely themselves for infrastructure necessary to support industry. However, the dilemma is that industry is most attracted to areas where this infrastructure is already in place or can be developed with no cost to them. Industry tends to not want to invest in municipal infrastructure, as that would mean a long-term commitment."

- "Oversized reservoirs should be created and filled as needed every 5-10 years, and filled to 50 percent of max levels half of the time. There's potential for this in Pembina Valley, where it would also be great for tourism and recreation. This would enable more irrigated land in Manitoba to support processing plants and reduce risk to growers. It could also offset some of the cost to the province of business risk management programs such as agri-stability and agri-insurance, and create room for more processing plants in Manitoba to deal with food waste."

- "I strongly encourage the idea of studying water problems by sector. How can you problem solve and create something that's better for the future if you don't understand Manitoba's current water issues by sector? If you want to move to anything different you need to define the current state, and then define the desired future state, and then you develop action plans to get there in the future. I don't see the urgency necessary, especially as climate change is getting worse. You've got growth opportunities outside of Winnipeg — there's Brandon, but what if there's no more water on the Assiniboine? You've got the Niverville-Steinbach area, but what about if there's no more water underneath them? You've got the Winkler-Morden corridor, another growth area — what if they don't have any more water? You've got to think about economic development, you can't just create a strategy that's all about words."

"As much as policy makers focus on water supplies and infrastructure and those things, they also need to pay attention to the changing behaviour of humans and how that plays a very important role in water management."

Enhance water supply for sustainable development continued

- "Manitoba was an attractive destination for our new facility because the location provides access to hydroelectric power and an ample supply of pre-treated fresh water, but there is a gap in working with government agencies when it comes to purchasing treated water and waste-water services. The issue starts with a lack of meaningful engagement with industry on their needs and strategic timelines. It is currently more of a one-way conversation where we are told a price and there is no flexibility or opportunity to work together on sustainable solutions."

> **"Industry leaders should explore the potential of how water can further generate diversification interests rather than simply intensification interests."**

- "Utility infrastructure and maintenance have been underfunded in Manitoba in for far too long, in some cases there have been decades with low investment. Manitoba has done a great job by getting us here and they are very keen to leverage us to attract spin-off businesses to locate near us. We want to support their business development efforts, but can the area support the water needs of those companies too? Probably not due to lack of investment in the required infrastructure.

- "Manitoba has tremendous opportunity around hydroelectric power as consumers drive demand for goods manufactured with sustainable energy. But the costs associated with purchasing water and wastewater treatment services really undermines the potential attraction to the province's sustainable energy offer."

- "I spend a fair amount of time dealing with international investment attraction and foreign direct investment (FDI), and I think there are certain advantages Manitoba has in terms of presenting itself as a jurisdiction that is set up for the future with relatively clean energy and relative climate resilience in terms of what we offer — generally good access to fresh water and flood protection in particular. But the flipside is how exactly we go about promoting these as a business attraction and retention tool. There have to be questions asked at some point of: Okay, but what are we doing with this water? A business can come in and use it — but to what effect does it contribute to that industry, what other impacts is that having, what products are they producing? You know, is it being used to produce food? Is it being used to produce food in a sustainable way that really uses resources efficiently? Or is it going to just be access to abundant cheap water to mass-produce consumer widgets?"

- "If you want to see continued economic growth, alongside population growth in some areas, you're going to have to prove to yourself and would-be investors that you know your water budget, you know what options you have to increase your water budget, and you know your climate risk on that water budget. And you understand on the demand side what your so-called soft path or conservation options are."

- "Well, here's what I haven't figured out: is Manitoba going to be another version of South Dakota, North Dakota, or Illinois? Are we headed to a state of corn and soybeans – just keep it simple and pound the resources to it, including water – or will we have a very diverse crop mix? That diversification question, I think, is a really critical one to what the overall strategy for water use might be. Industry leaders should explore the potential of how water can further generate diversification interests rather than simply intensification interests."

Residential water demand in Manitoba will increase as t he province's population is set to grow by several hundred thousand by 2040. *Photo: Luis Quintero/Pexels*

Focus 2

Make every drop count through efficient water use

- "I think that on the water side there's probably really strong opportunities through industrial symbiosis; things like co-locating production sites, use of waste heat in water, and use of heat itself in water. There's some really interesting climate and water synergies — in most municipalities, water systems are one of their biggest corporate energy users. So if you have water mains that are leaking, which happens in many older municipalities, then you're losing 20% of your water, which also contains embedded energy loss alongside the water loss. So I'd be looking at water efficiency to begin with, along with better use of cleaner volumes of wastewater, and waste heat around water in other sectors."

- "In times of drought farmers with water rights won't want to give these up voluntarily, so one solution might be for the government to offer to temporarily buy back water rights when drought conditions emerge. This would allow farmers to grow what they want when water supplies are sufficient, but can be a mechanism to save water when water supplies are low without affecting the livelihood of farmers."

- "Higher user rates could help to offset some of the cost of maintaining and upgrading infrastructure to help with water management, but you need a gradual cost adjustment strategy to phase these things in. You can't have rates doubling or tripling every year, but something in the rate of double digit increases percentage-wise may be feasible. But you need a transition strategy. Intelligent pricing is the key element here — you can't just have an information campaign around water conservation but still provide it almost free of charge and expect that users will get smart and change their behaviour."

> **"When you underprice a resource the natural result is that you get overconsumption. This has gone under the radar screen of most jurisdictions, which has a big impact on the effectiveness of conservation strategies."**

- "Long periods of drought will be challenging regarding raw water supplies. Costs will require municipalities to develop alternative water sources such as new ground-water sources and interconnecting systems between co-ops and municipalities. The infrastructure needed to develop these alternate supplies will ultimately have to be paid for through customers and sale of water. Potable water will become much more expensive and, as a result, we'll likely need to reduce water consumption per capita similar to European levels. I think there are areas in the province where municipalities have just kept the price of water as low as they could for years and years and years. But now that the systems have deteriorated, they have no money to upgrade them. So the only way to do that now is to spend a lot of money, which typically requires securing a handout from the government."

- "The impact of climate change will also impact water consumer expectations, and requires early education on conservation to help mitigate impacts of shortages like those experienced in Morden this past summer. We need to be adopting some of the public education programs that have been implemented in more arid climates in California, Nevada, Europe, and others. We need to teach consumers to use less water because it will help us alleviate some of the burden on existing infrastructure without having to increase the overall capacity of the system."

- "Doing a better job of recycling water would help. To enable the agriculture and agri-food processing sectors to take advantage of market opportunities will also require working to bring some municipalities around to the benefits of expanding irrigation and creating a more accurate portrayal of the positives of irrigation. Instead, there appears to be this public perception that expanding irrigation capacity will hurt the environment and reduce drinking water supplies, both of which are untrue."

- "There needs to be ways found to capture spring runoff to reduce flooding for years when we need it. Variability rate technology, drip tape irrigation, and more water recycling methods and tools in wash plants and processing plants can also boost water use efficiency. Aquifers could be recharged with excess spring water."

- "On water issues it can't be a one-way dynamic — there needs to be more ways to work with industry on solving problems. You know how Manitoba Hydro has Efficiency Manitoba as its offshoot? It would be interesting to see if the Province could strike something similar around water for industrial users. So they come in and work with you to analyze where businesses can increase efficiencies and make significant savings around water and wastewater, and water recycling and that stuff.That's something we would want to see explored."

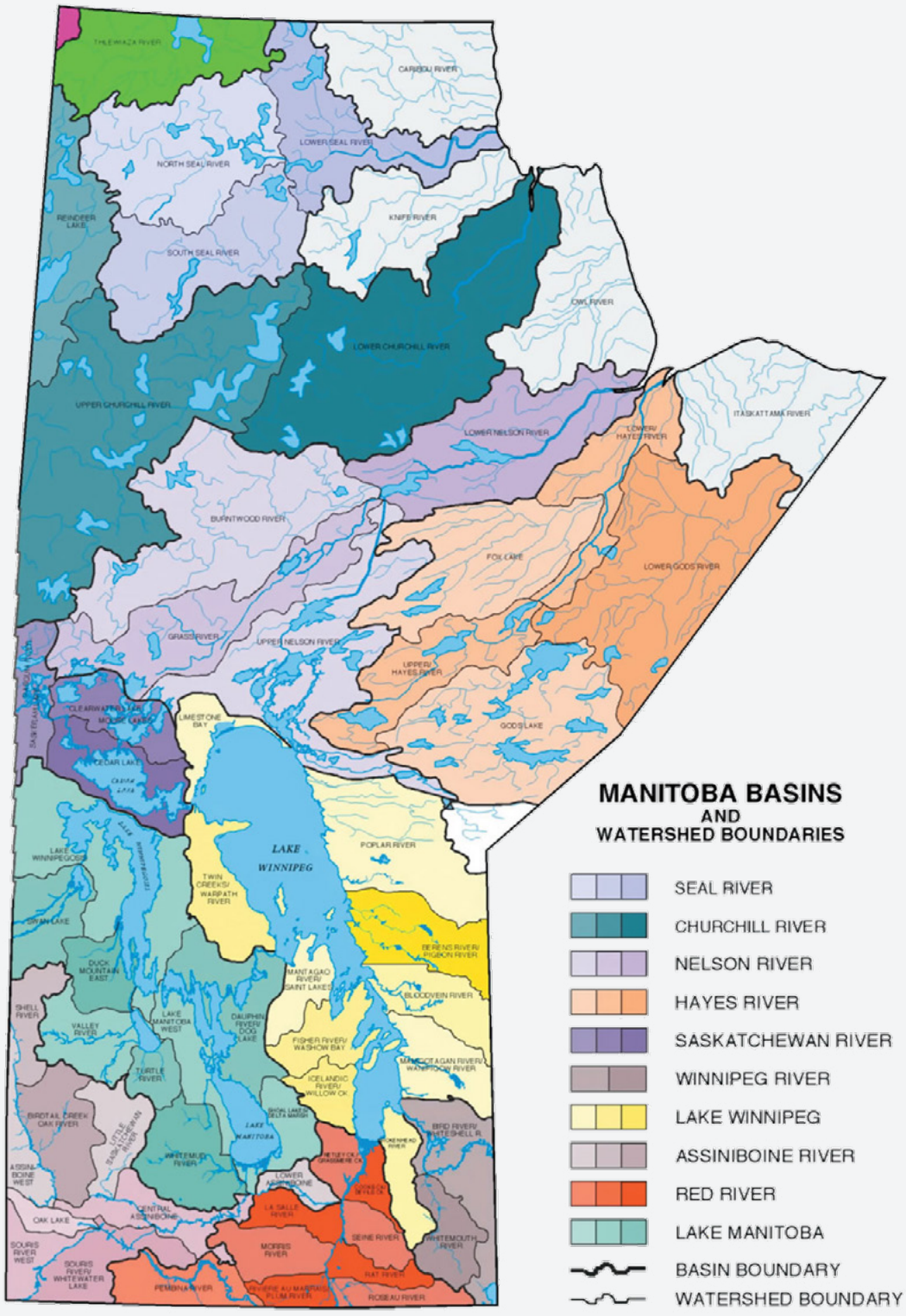


Image: Government of Manitoba

Focus 3

Support coordinated water management and governance across watersheds and basins

- "The hardest thing will be getting clear measurables on outcomes — you probably won't be able to do it quickly, and it will require evolving along the way. Not everyone will agree with the outcomes as well. So there needs to be some sort of conflict resolution mechanism too. There will be trade-offs here, given the state of water and climate change moving forward, so just because you have principles in place doesn't mean that they will be able to mitigate or avoid conflict over water at some point. So those pieces that address the social dimensions of the water management strategy's outcomes are just as important as any other principles you might have around water quality or quantity."

- "You need an organization in the government focused on water — and just one standalone entity. The watershed districts, the work they're doing with the marshes and with the farmers, that's fantastic work, but you need to massively scale it up. If you don't want to create a new agency, then give it to the Manitoba Water Services Board and give them a lot more money and clout to deal with the big stuff. If you give them legitimacy by saying everything provincially in terms of water is to go through them, and you give them money, they could do it. And make a policy to support regional co-ops. Have leadership at the provincial level dealing with water across the whole province. Don't have water scattered all over different government agencies so that no one understands how important it is. You need programs and you need funding. And if you don't have funding, tie it to the Canadian Water Agency. Manitoba can't delegate the future of the province away to the municipalities and watershed districts, which already face a backlog of over $700 million in needed water and wastewater treatment facilities and sewer infrastructure."

- "The province cannot abdicate its responsibility to look at things regionally and provincially. The strategy is always to deal with individual municipalities with a tiny bit of funding, but that doesn't work. A real weakness in Manitoba is the government structure — there's no real ownership for water. When I want to talk to someone about ownership of dams or water treatment plants, for example, it's owned by Manitoba Infrastructure, but they don't want to put any money into upgrading these things. So they're being given responsibility but no authority or budgets to do anything. There's also no provincial water planning process. Right now it's being left up to entrepreneurship to find solutions to water problems, having to go around the government, which is still putting in roadblocks every step of the way."

"There's currently no motivation to say yes to water projects but rather to say no."

- "Over time we've found that government departments have a tendency to become siloed and create strategies or pursue their own initiatives without really communicating with one another, and it just gets very confusing. One of the problems that Manitoba has had is that some of the regulation of things that impact water are in one ministry, and the regulation of other parts of that are in a different ministry. And neither of them understand what the other ministry is up to."

- "For global organizations like ours that don't necessarily have all the local contacts or established relationships in place, there's so many different levels of government that need to be worked with that it can be enough to scare away investors. If there was one single point of contact to help organizations evaluate, assess and get through all of the appropriate steps around economic development and water, that would be really helpful."

Aerial of Riding Mountain National Park, Manitoba, Canada
Photo: Russ Heinl/Shutterstock

- "The other thing about water-related infrastructure is that it is a bit of a Wild West. Just from speaking to producers or driving around and seeing what producers are doing in their own fields in terms of what might be called in-field drainage and other things, people kind of do whatever they want. There's a lack of oversight and there's a lack of appreciation of what happens upstream has an effect on what happens downstream. A producer may do what is good for them, but they may flood their downstream neighbour or affect their upstream neighbour as well. Part of the problem is that this is a big province with not a big population, so that kind of plays into it a bit."

- "We're starting to see that Manitoba is not an island of water stability. Certainly in the coming decades we're going to see watersheds in Saskatchewan and other jurisdictions in trouble, and going forward they may have difficulty meeting their current licensing requirements, let alone the irrigation that is being planned. Yet we rarely hear of any cross-border discussion of water issues. Not that there isn't any dialogue going on at times, but it just shows that this isn't a topic that's top of mind for a lot of people in Manitoba."

"One of the weaknesses that I think has always been the case in water is those crossovers about what is municipal responsibility, what's professional or businesses' responsibility. Who really knows?"

- "The frustrating part of water management in this province is how it has been shuffled around through so many departments over the last two governments that we can't even keep track of it really anymore. And if you're a stakeholder, it's like, "Okay, who's in charge today? How do I get my issue or opportunity resolved in a timely fashion?" It is so disruptive to businesses, trying to manage complex water issues and projects, when the roles and responsibilities within government are shifting every year. So, I just feel like we're backtracking sometimes when there's always these shuffles going on. Adequate staffing within these departments is important too."

- "There absolutely needs to be some form of conflict resolution mechanism around water going forward, but even more important, there needs to be some form of leadership and some form of tools – the idea of not just that there's a mechanism where there's an arbitrator that picks who wins, but there's a mechanism that wrestles and proves that they're attempting to wrestle with the wicked problem of water management and never pretends that there's a perfect solution to it. "

Focus 4

Advance Indigenous inclusion in water management

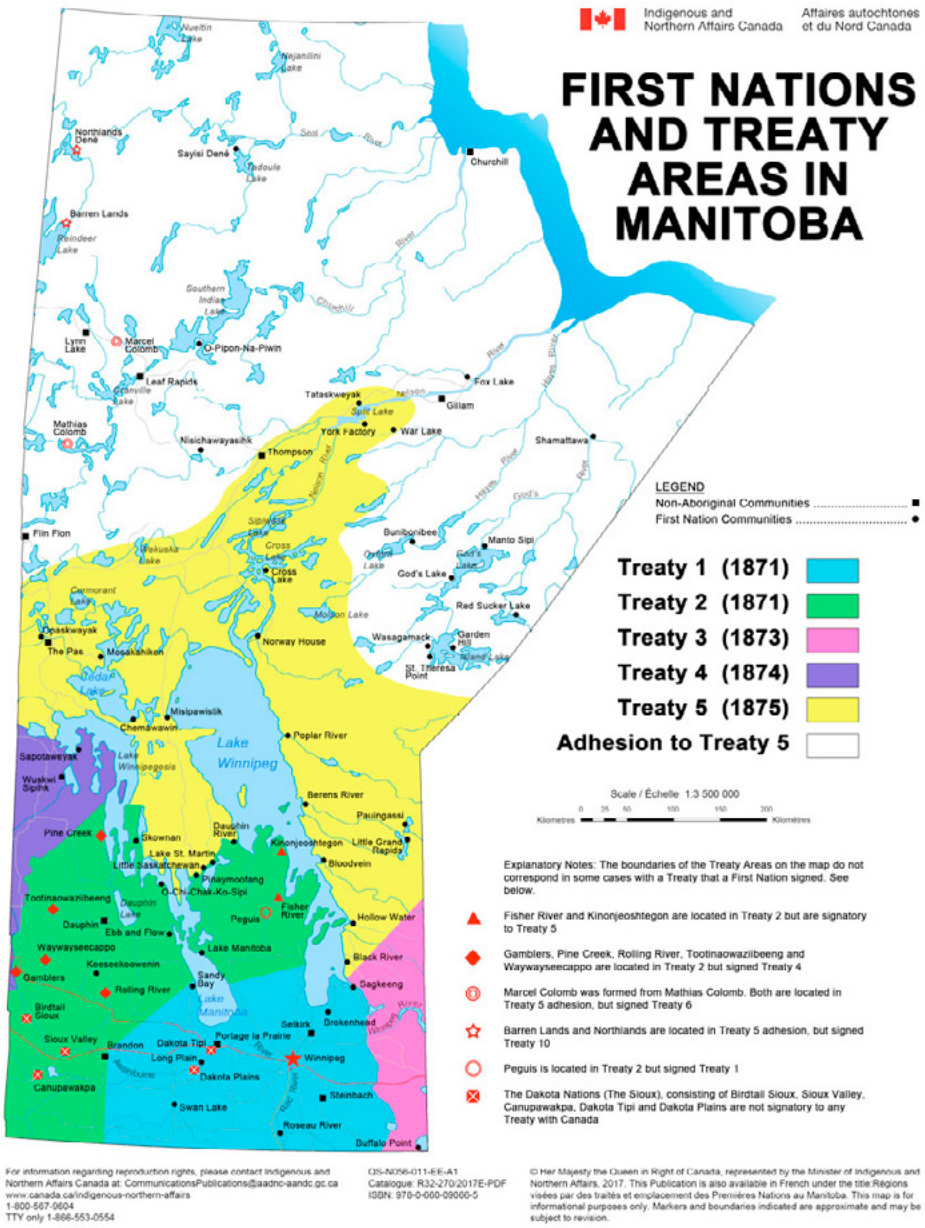
*Some comments originate from non-Indigenous persons, and are not intended to replace or represent Indigenous viewpoints

- "I think one of the challenges with Indigenous knowledge is that it's not going to be immediate. I mean, it's both and isn't at the same time. Some challenges around that, first of all, is that with Indigenous people, generally, there's been a real stress between the relationship with the government, sometimes neighbouring land owners, and Indigenous people. We can't really fix that overnight, even with the best of intentions on all sides."

- "Anecdotally, First Nations have said that they are often consumed with managing other elements within their communities and may not always be able to effectively contribute to the standard form of engagement, but have lots to offer in terms of contributing to water management planning. However, they need some help with this — including training and staff to be able to effectively contribute. Again, from an education and awareness perspective, making sure that all key stakeholders across the province have the training, knowledge and tools required to effectively contribute to a water management strategy will be crucial. That Indigenous participation needs to be empowered in any way that they need."

- "It's going to be important to have a mixture of solutions. And they may all be just as important to each other, but have radically different costs associated with them. For example, we need to spend $1.8 billion on fixing the North End water treatment plant, but we also need to work on much lower cost, nature-based filtration solutions, like conservation of wetlands and the like. For example, there's some incredible research work being done in the Netley/Libau Marsh area around dredging and dealing with water flows from the Red River to Lake Winnipeg where natural filtering occurred in the past and can be recreated for the future. Putting money toward continued research and operations in this direction is a relatively small expense that could have a huge effect. Also, much of the area involved in that marsh project is Indigenous land, so being able to find ways to work with First Nations communities on the water issue will be hugely beneficial in terms of getting everyone on the same page and working towards the same solutions and outcomes. It's clearly an area worth spending some political capital and money."

"By and large, I have not met many First Nation band councils who feel like they are getting all the proper water data shared with them that should be. The Province could do a better job of that kind of data outreach."



QS-N056-011-EE-A1
Catalogue: R32-270/2017E-PDF
ISBN: 978-0-660-09000-5

- "The lack of clean drinking water and wastewater treatment facilities in all remote Indigenous communities will only become more of an issue in the future."

- "There's been more and more talk about the importance of these development proposals for northern Manitoba, like mining expansion, but none about the water implications that this would have. The biggest source of contention is going to be Indigenous concerns. In terms of traditional territory, there's definitely going to be conflict. You've got to get these communities properly engaged, brought on board and secure buy-in for these water projects. Without that it's going to just be a mess if infrastructure development is just pushed through."

- "When we talk about Indigenous knowledge, it's also important to think about it a little differently than we might with scientific data, or these other important data points, is that often, it's going to be centered still around the people themselves who will have really hyper-local context for things. It's interesting. It's something I need to actually put some more thought into, around how as we go forward, because it's not as simple as just putting data points that can be just put into an algorithm, or even into a spreadsheet, as it were."

Focus 5

Increase our understanding of groundwater supply and quality and its interrelationship with other parts of the environment

- "There are areas of Manitoba with an abundance of groundwater supplies and its withdrawal is contentious especially if pumped outside of the municipal jurisdiction. It's a very sensitive issue, because even though the water that is underneath the ground isn't owned by the municipality — it's owned by the Crown — communities are still very protective of it."

- "Manitoba Water Services Board has actually implemented a sort of small-scale conflict resolution mechanism where we've developed a groundwater impact protocol for some municipalities, so that if there's somebody with a private well that they think is being impacted by the municipalities there's a process for them to follow. We actually haven't had to go through that process yet, but we've prepared that protocol for the municipalities in case they have to go through that process."

- "Aquifer recharging is at risk in southern Manitoba, and the impact of salinity in the existing aquifers needs a long-term strategy to prevent well-sourced water contamination, as the salinity in the water table in Western Manitoba has gradually been creeping eastward. If the salinity changes too much you have to invest in infrastructure to treat that water to make it suitable for consumption, agriculture and industry."

- "For us it's important to know the current state of aquifers and groundwater – and how recent and accurate that information is. There's the perception out there that the province and municipalities give sacred status to groundwater and that it can't be spared or shared with other jurisdictions that need it."

Focus 6

Build our resilience to a variable and changing climate

- "There is more economic opportunity lost and damage done around intense rainfall for most growers, with the exception of potatoes. There's at least as much work to do to regroup and think around how drainage happens as there is about creating potential for irrigation."

- "To keep attracting businesses amid changes to climate, you've got to be able to connect climate risk analytics on hydrology and a geospatial match of supply and demand informed by every intelligent conservation measure possible. Investors are not going to tolerate fluff. They'll say: Sure, you've got this lovely document and with platitude after platitude, lovely. I'm still not spending my money here."

> **"We are a downstream jurisdiction and when it's flooding, we're getting lots of water, but when it's a drought, we're barely getting any. So how do we solve that? We've got to consider water quality, water storage and flood damage reduction as an integrated system."**

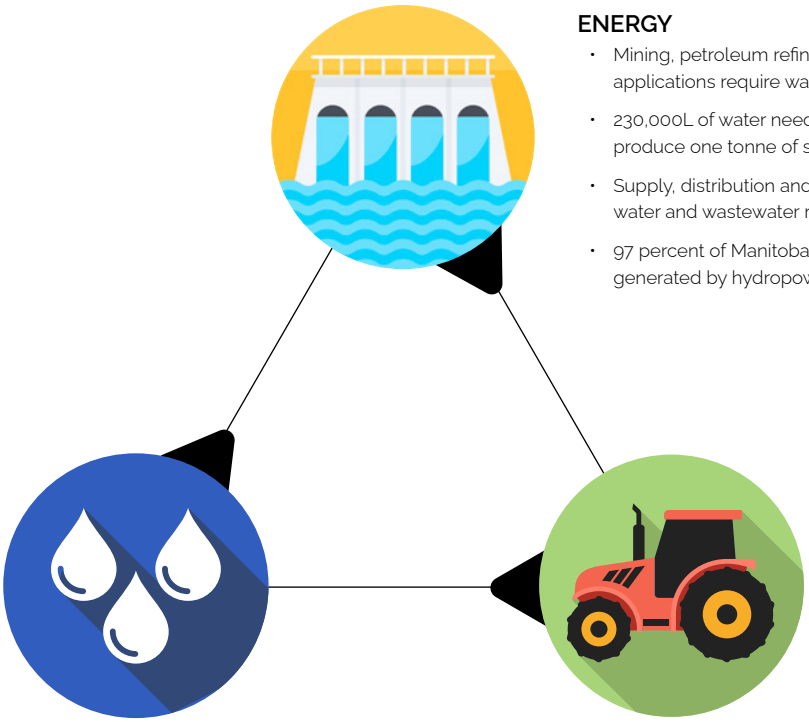
- "In terms of principles, the word that's important here is that it has to be regenerative, so that we're not just minimizing the harm we're causing to the natural environment, but we're actually working toward processes that improve the health of the environment at the same time that we're operating industries and attracting new businesses. And that principle is not at all being adopted right now. I mean it's being dabbled in here and there, but as a broad guiding principle it's nowhere near prevalent enough in a way that's needed to ensure that in 100 years time we still have adequate water supplies."

- "If we start to think about extremes, during flood years, when we hold back water, who's going to get flooded out? Again, when you think about priorities, what are we going to do to support those people that get flooded out to save Winnipeg? When they back up the Red River to divert water around, everyone downstream gets the negative end of that. We've got enough history about this and mapping of where floods actually occur, that we can be very specific about the trade-offs the government should be making around this. I don't think these outcomes should be presented as a surprise to people. We have to kind of bite the bullet and say: there is a management challenge around water and here's how we plan on managing it, and put that plan out there publicly and promote it consistently."

- "When it comes to more extreme drought in the future, causing water tables to drop who gets priority - is it cities, is it processors, is it municipalities, is it irrigation? Those are questions that are going to be very, very contentious. Some of the gaps around water in Manitoba right now are really around communications. We have a fairly good disaster management sequence but it doesn't stretch across the province in terms of rural municipalities and small towns even understanding what they need to be doing during water-related crises. An information campaign around where local water shortages are, or will be in the future and what the implications of those shortages are could be a place to start."

Interlinkages of Water, Food and Energy

Water availability can have major consequences on energy, food and water suplies



ENERGY

- Mining, petroleum refinement and industrial applications require water as an input or coolant
- 230,000L of water needed to produce one tonne of steel
- Supply, distribution and treatment of water and wastewater requires energy
- 97 percent of Manitoba's electricity generated by hydropower

WATER

- Increasing efficiency of water use can lower energy demand
- Wastewater from agriculture and industry affects water quality of rivers and lakes
- Commercial and residential land development requires access to water
- Population growth will increase water demand

FOOD

- Irrigation expansion a critical component to offset moisture variation from climate change
- Agriculture contributes 5 percent of Manitoba's GDP, $1.7 billion in labour income
- Water used in livestock production, aquaculture, food processing, and beverage production
- Higher value produce, like fruits and vegetables, require greater water inputs

Build our resilience to a variable and changing climate cont.

- "Over the past two years we've seen capital markets really start to focus on the climate risk issue in ways that weren't even being considered three years ago. This includes obviously where to invest, but also the opportunities on the government side as well to create new financial instruments when it comes to green bonds, green credit trading markets and other things. So the flipside of the risk climate poses to credit ratings is the opportunity it presents in order to come up with new ways of financing new projects and infrastructure. In a similar way, dealing with water management issues is something that, three years ago, many people may not have thought was that important. But now, the way it ties it to a changing climate, I think that's going to be game-changing — you're going to have way more people saying water issues are important now."

- "Insurance costs are going to increase with climate change, no doubt. Crop insurance rates are going to go up, and the other part of that is the market is going to change. Perimetric insurance will become more popular — where insurance is triggered by an event. For example, if at any time during the growing season the level of available moisture or precipitation falls one standard deviation below normal that triggers the insurance, rather than requiring a direct estimate of loss. Growers are going to be seeking more of that type of insurance product."

> **"To make themselves even more drought resistant, water cooperatives and municipalities are now investing to interconnect their systems together such that multiple raw and treated water sources are available for emergencies."**

- "Serious measures taken to increase the province's preparedness for climate change in terms of water are not clear, if any even exist. Both climate change and growth — in industry and population — are going to stress the existing system. The primary one that comes to mind is the Shoal Lake aqueduct. It's the longest unreinforced concrete pipe in the world, and if Winnipeg's population grows to over a million people in a reasonable time frame, do we have the capacity within that system to accommodate that? The second piece is that the aqueduct itself is an amazing piece of engineering and construction, but it is well over 100 years old and sometime in the not too distant future that is going to have to be replaced. And that's another megaproject, right? We're talking hundreds of millions, potentially over a billion dollars to replace that."

Photo: Daria Shevtsova/Pexels

- "The time is now for leadership at the provincial level to move water around in Manitoba so we have the right amount of water in the right places in anticipation of climate change, and so that we can get going for our secondary agriculture sector and economic development. Economic development projects are having to be turned down every month because we don't have water for them. Yet there's nobody at the provincial level that's taking the leadership to build a few dams, or similar types of projects. The Province keeps signalling that it wants to get out of the business of owning infrastructure, but on some of this big strategic stuff, you've got to own some infrastructure. But even when the government is given highly developed and technically precise project proposals, they're not willing to fund stuff like this, or don't have a program through which to provide funding."

- "It's crucial that we have more storage because you won't be able to provide ecosystem flows in many cases, you won't be able to keep benthic habitats (the aquatic habitats at the bottom of lakes and rivers) wet if you don't have storage. This habitat in this region has evolved in a rain fed environment where there's been sufficient season runoff to sustain habitat. That's increasingly risky and will not be true. We will bake benthic habitat if we don't have water in storage to charge it. I would say, where are you critically drought exposed? It's a kind of a habitat mapping exercise. Where are your drought exposed habitats? That's a geospatial analysis. Where are your drought-exposed habitat corridors and where could we protect them with investments in storage?"

Focus 7

Address our water infrastructure challenges and opportunities

- "Potato growers and vegetable growers are already sharing infrastructure today, and have collaborated on a lot of investment in irrigation in southern Manitoba and the province as a whole. We'd like to see more irrigation, of course, but growers are wary of partnering on projects with the Province and municipalities because bureaucracy and politics seem to frequently get in the way. Plans are often put in place before ultimately being aborted or cancelled by some municipal action or policy. If it makes sense on a provincial or economic level, local governments should not be able to stop these types of investments and projects, like what happened with the Boyne River Project."

  "There's an inherent need to leverage all available funding, including federal funding, to secure investments and partnerships with the Canadian Infrastructure Bank."

- "Speaking of infrastructure, there will also probably be a big focus on digital infrastructure going forward too. So for some of the things we've been talking about, including activity that relies on gathering a lot of data, the wide roll-out of rural broadband will probably be very important to collecting that information on the natural environment too."

- "The success of natural infrastructure projects and nature-based solutions are ultimately dependent on willing landowners, not necessarily a project's proximity to location or density of natural assets. Again, you have to get the interest of landowners and the public, and changing that mindset away from pure land productivity value can be a challenge. Bringing natural capital assets into the financial world would also operate to help people understand how these assets impact their lives and how they're critical for our survival."

- "The ability for livestock to utilize marginal land that really shouldn't be converted to a more commodity crop production is why they have an important role in maintaining some of those natural infrastructures, such as wetlands and grasslands, that are able to hold more water than anything that can be human built."

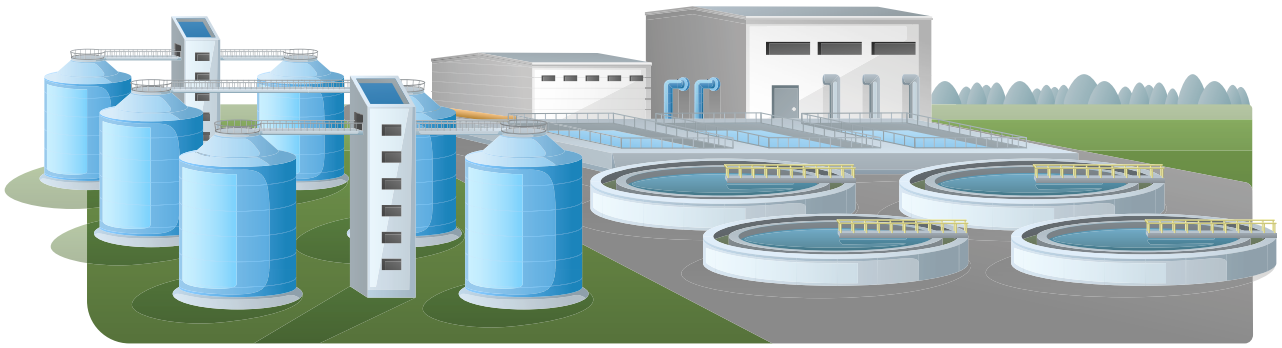
Livestock can play an important role in land and water management in areas of high ecological value, and are a key component of Manitoba's efforts to become a world leader in sustainable protein production. *Photo: Skitterphoto/Pexels*

- "We have this unravelling of institutional capacity around built natural infrastructure and the investments that we're making through the Conservation Trust and the watershed district programs are only starting now, and they're idiosyncratic. They're not systematic. We're sprinkling fairy dust around, but not making the institutional capacity investments to really understand how natural infrastructure has to function in the hydrologic context. The reason is that the expert civil engineering capacity in this province is built around hard rock, heavy, lumpy, high capital expenditure projects."

- "Most people think that we need to upgrade Winnipeg's North End treatment plant so that we can have better water quality in Lake Winnipeg, but the fact of the matter is that the site has to be upgraded for Winnipeg just to have water and sewer available on an expanding basis in Winnipeg. We're coming radically close in reasonable planning horizons to having to shut down new development in Winnipeg, both residential and commercial, because we don't have sufficient sewage capacity. In the grand scheme of things, it will take several years to get the North End treatment plant in proper running shape, and the crossover of when we might have to stop and pull back development is eerily close. We need to understand how we're going to handle capacity limitations of sewage of all things, and how politically unpopular that's going to be."

- "The major investment needed in wastewater treatment and combined sewer separation infrastructure poses a significant burden on the City of Winnipeg and other major communities. Balanced support for these projects from all levels of government is required otherwise other municipal infrastructure will suffer from lack of investment. Taxpayers have a limit. The major urban centres will suffer from deterioration of roads, bridges, buildings while water treatment infrastructure is being addressed. This limits our attractiveness to investors and developers in our cities. With us having to pay for that now, will we have to defer investment in other infrastructure like those roads, bridges and buildings — or do we take on more deficit as a province?"

- "Manitoba is not a large economy, so our industry — engineering, construction, craft labour and trades required — is somewhere around 25,000-30,000 people, a level that can sometimes have difficulty executing these kinds of large-scale infrastructure projects that often need to happen in very remote locations. When you're talking about taking on megaprojects, it usually means it's going to overburden industries in Manitoba, so you see large international organizations come in and some of the government investment in these assets is leaving the province. So part of the water strategy should be how could Manitoba's industry be grown to a scale necessary to take on this infrastructure work, so that these Manitoba-based companies are reinvesting in people and plants and equipment in our province. One of the challenges is for the Province to come up with a plan, and stick to it. Our industry can react and grow, but we need reliable information, we need to have a plan, and it needs to be communicated to the industry what that plan is. If the industry knows that work is coming, it can prepare itself for anticipated growth."



- "Most of the government programs for climate adaptation, resilience and infrastructure, they're all scaled for large engineering projects, so the capital threshold almost by definition excludes natural, much more affordable infrastructure solutions. So it's almost as if there needs to be a different metric used to compare the options, because a lot of the federal programs, you're not even in the conversation — the federal government tends to be focused on very large engineered infrastructure projects. By definition natural capital projects may comprise a long series of small projects, community by community along an entire watershed. So there's also the question of if there's a way to bundle these natural infrastructure projects together so that they reach the scale necessary to appeal to the green bonds market, which is very eager to find investment opportunities and lots of municipalities are very curious about. But most of the projects are so far off the scale that the market is working at, or even federal or provincial infrastructure investment programs."

- "In terms of co-investment in infrastructure and joint public-private partnerships, I can see that you're going to have some companies, depending on certain industries, are going to favour some of these approaches and be willing to co-invest because they want to maintain their license to operate. There's going to be some that out of pure necessity are going to need greater climate resilience protections built into infrastructure to be able to continue. Then there's going to be others that say: 'We weren't the main ones that caused a lot of the things that we're dealing with, so do we really have to pay for it?' There's a certain tragedy of the commons dynamic at play to all of this, for sure. Business has a role to play in this, but clear policies need to guide the making of rules that apply to common goods and systemic things that individual businesses can't or won't support on their own."

- "To promote nature-based solutions we need documentation of how ecosystem services have been monetized, the precedence for them being accepted, and whether it's by Infrastructure Canada, or the BC Department of Highways or wherever, we need a document that is a living, breathing document that says: "Yes, you can use this number for dollars per hectare of habitat or dollars per kilogram of phosphorus intercepted. And this has been accepted by the Alberta Department of the Environment", and so on. Find something like that and leverage it because everyone is starting from scratch and fumbling in the dark on this."

Focus 8

Improve surface water quality

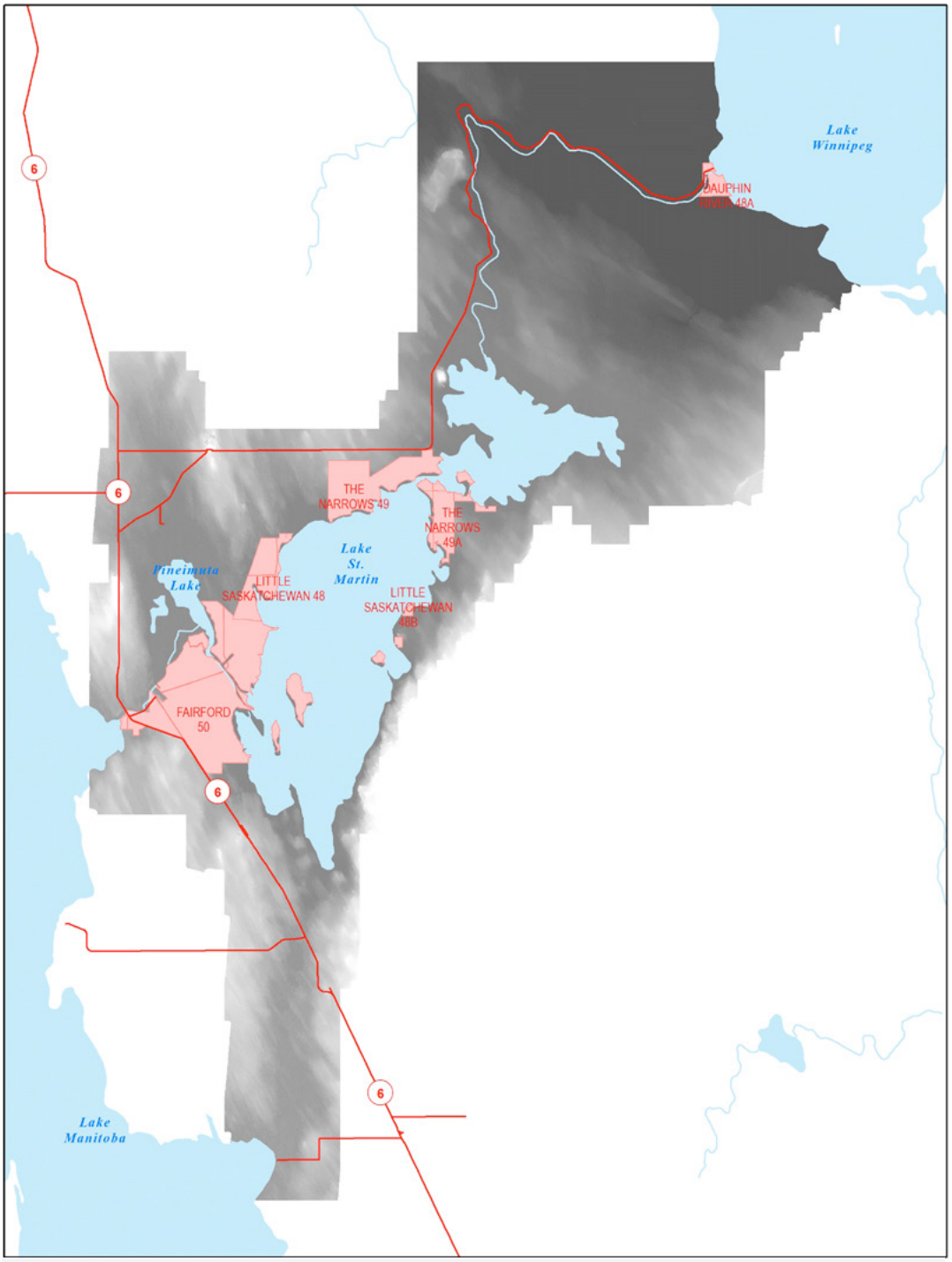
- "I don't believe Manitoba has a comprehensive high resolution elevation map of the province, a LiDAR type elevation map. If you're going to start trying to manage excess water, and water runoff quality, something like that would be very useful for land managers, particularly in the agricultural sector. A lot of the US states have 1 metre resolution LiDAR elevation models available to growers for free. Now, I don't think you necessarily have to give these models away for free, but it is a pretty powerful resource when you're trying to manage water on the landscape."

> **"To be able to have a successful water management strategy, there's an importance to being able to enforce those rules. It's great to make a rule, great to make a strategy, but if we're not prepared to spend the money to enforce it, to make sure it was working, then there's a problem there."**

- "Manitoba uses a kind of one-size-fits-all approach to phosphorus loading on soils, and those are the kinds of things they're going to have to rethink when we go into an era where flooding may not become more frequent, but it may become more severe — we just don't know yet. So you're going to have to look at more management of nutrient source areas, plans for how to address those particular areas that need updating, rather than managing the entire land base as if it's uniform from a water quality standpoint."

- "First of all, to improve water quality we need much better regulatory enforcement of current regulations that do exist, and added regulations around livestock access to fresh water. We hear a lot about challenges around enforcement; that's something that the watershed districts have identified as a way to improve water management. Current laws and policies related to limiting wetland loss don't seem to be working, and nothing concrete is being done — which circles back to the need to enforce existing laws and regulations better before creating new ones."

- "Along with better LiDAR data, more information is also necessary on other things, such as the mapping of drainage networks. A lot of small ditches and things aren't necessarily mapped, so trying to get an understanding of where water is moving can be difficult. We often delineate watersheds based on processes using LiDAR and things like that, but when we go out and visit the space in-person we find out that: Oh, well there's a culvert underneath the road, so it drains that area or a connecting area differently than we thought. Things are constantly changing, especially when you're in the upper reaches of the watershed as well, where streams are small or intermittent, or there's ditches and things like that. That information is severely lacking right now."



A LiDAR image of the Lake St. Martin area. Numerous stakeholders argue that blanket LiDAR coverage would hold numerous benefits for water management.
Source: Government of Manitoba

Focus 9

Protect biodiversity and support aquatic ecosystems health

- "Urban and industrial uses, versus agriculture, versus maintaining ecosystems is going to be the major three-part dilemma for economic growth and environmental health. Manitoba isn't that urban — you've only got one big city — so I think the main issues are going to be what happens if you start large-scale irrigation in certain areas of the province, there could be conflicts with the natural ecosystem requirements."

> **"How are you going to incentivize land managers to make changes? Natural infrastructure will continue to disappear unless land managers are incentivized to protect it."**

- "Focusing on water-holding capacity of the soil like carbon content and soil moisture can help identify healthy watersheds, along with utilizing other datasets that already exist like stream flow, water stations, etc. Other data points are nutrient levels, sedimentation, fish population, all important for conservation and ecosystem health. Some nutrient data is available through the Lake Winnipeg Basin monitoring program, sedimentation data hasn't been collected for decades, and fish population data is nearly impossible to obtain for Dauphin Lake and its tributaries. LiDAR data is most important for surface water management, hydrology studies, and project planning."

- "It is quite possible that you would get better and quicker solutions through nature-based solutions than you will through the $1.8 billion and the 10-12 years that it will take to fix the North End treatment plant. In many ways nature-based solutions are misinterpreted as long-term solutions, because they can be implemented and produce outcomes in a much shorter timespan than more capital-intensive decade-long solutions. Plus, in the debate over nature-based solutions versus land development, it's often overlooked that nature-based solutions sit in areas that aren't all that worth developing anyway — it's marsh, it's going to give you negligible gain in the long run anyway to convert it too development purposes, so why not keep the area suitable for wildlife and the other benefits, like tourism or recreation."

- "We have to commit to adequately monitoring ecological performance and function on the landscape when we implement a new nature-based solution. Otherwise, we're just counting projects implemented, and we're not actually clear on the ecological goods and services that they've achieved, or the positive impact they've had on protecting water quality, or reducing peak floods, or improving wild-

life habitat. Policy makers and land managers also need to clearly identify which ecological objectives are being sought through each project they implement. It's easy to be seduced by the idea of a single solution that provides multiple, cumulating environmental benefits – many environmental funders are at risk of this. But in reality, there are no silver bullets – there are always trade-offs to consider. Every project needs to be assessed to determine which priority ecological benefit must be achieved at that particular site."

- "At a very conservative estimate — acknowledging only the replacement cost of an engineered structure to provide a similar service, and that it's only a fraction of the types of services being provided by the natural assets — across the projects we've looked at nature-based solutions cost about 15-20 percent of what an equivalent engineered piece of infrastructure would, and with no future cost of replacement and ongoing maintenance. These solutions also provide lots of benefits around biodiversity, so you kind of get a double-dividend so to speak, around say, flood alleviation and biodiversity support, as well as recreation. Once you've got those, that creates a cascade of other benefits, around issues such as increased property values and stuff that is often more formally monetized in an ecosystem services evaluation. But that really all starts from the fact that you've got more green space, flood retention, biodiversity, and even water clarity. The lodestar for us is to at least phase in consideration of natural assets as an alternative in any infrastructure funding proposal. It's something that could be phased in over time."

Focus 10

Improve the information and knowledge available for effective water management and decision-making

- "Across all of the policy approaches that the province might use, the government must commit to evidence-based decision making. This means: identifying and collecting the necessary data to support decision making; demonstrating how this evidence is being integrated into policy decisions, and; targeted monitoring of on-the-ground impacts of policy choices."

- "We need a geospatially articulated master plan w here we're driving regional hydrologic modelling using the best available climate data. And we say, "Okay, these are the risk levels on water supply in this part of the province. This is our projected population forecast." You then create a hydrologic budget, you know what your options are from a technical basis because we have the LiDAR and we can do the analysis quickly of what the hydraulic options are to bring more water into this region. You also have population projections and you know per capita use of water with, and without conservation measures. So fundamentally you've got a geospatial master plan, a matching challenge."

- "We've worked recently with a soybean producer and some economic development officers (EDOs) in the west part of the province, and neither of them could get adequate evidence around the kind of water that they needed, and whether it's available. So small towns that are looking at moving away from using groundwater and wondering about whether there is any limitations on their water licensing capacity and water quality and quantity, there was no one person or office that they could go to learn about the kind of things they need to know about when considering whether to, say, enlarge their water treatment plant. That was really quite surprising. I don't think EDOs are well-equipped around understanding the limitations of water to their municipality or their rural region."

- "Having information all in one spot — real-time updated information — and public education in place are things that would really help. Making sure information is all in one spot and that inconsistencies can be mitigated is really important. Having to navigate different websites — and then you have federal programs on top of everything — can make it all very confusing. Data has to be fit for purpose in regards to accuracy, and it's got to be accessible within a portal that it can be taken out of easily and put to use by businesses, researchers, farmers, government, industry, and communities."

A lakeside campsite at Otter Falls Provincial Park. Recreation on Manitoba's lakes and rivers produces significant economic benefit. *Photo: mysticenergy/Getty Images Signature/Canva*

- "We don't have as many businesses in Manitoba as we do in other parts of Canada, but there's a feeling that there isn't the same level of information, infrastructure understanding or forward-thinking here around water as there are in jurisdictions elsewhere. You can find thought partners in other places where you are able to meet and talk through what exists and what is possible, but it doesn't seem like that exists here to the same degree."

> **"I think that education around water is a key component of this strategy, because I don't think that people understand that. As much as we have an infrastructure gap around water in the province, we also have as much — if not more — of a knowledge gap."**

- "We need to understand the concentration of contaminants such as phosphorus and so forth coming into the water supply in Manitoba and in-and-out of Winnipeg and the various municipalities. That's very important if we want to hold appropriate governments responsible for their conduct. If they can all keep pointing fingers — and on this issue of course all the non-Winnipeg municipalities want to just say: Oh the real problem is Winnipeg, even though Winnipeg is simply the equivalent of multiple other municipalities — then they get to all defer action. However, if you can't prove that and show it to them and say: Look, this is what you're contributing to the problem, what are you going to do about it?, they are able to just hide from the problem and ignore it.

- "Some municipal governments are in debt with no borrowing capacity such that even with government funding assistance cannot finance the municipal share of the project. It might be prudent to integrate or have a separate tool to track operational costs, water usage and inflation in order to adjust water rates and budget for future upgrades. Maybe such a tool could be used not only at the utility or municipal level but a provincial tool for planning infrastructure funding needs. The Manitoba Water Services Board also did some asset management planning with about 15 different municipalities to develop financial management plans for their sewer and water systems. But once the plans were developed it was up to municipalities to update and maintain it and they just didn't have the resources and expertise to do that."

- "There's a lack of clarity right now around water resources in the province – who owns the water? Which entities have authority and oversight over water? There are even questions about whether we have accurate information on water resources. Allocation right now appears to be more politically motivated or determined, and not based on science. A new strategy should begin with reassessing provincial water resources to get a proper baseline understanding of what we have, and use it accordingly, rather than unnecessarily safeguarding it or installing regulatory measures in a way that stifles investment and economic development. Bureaucrats are trying to manage water risks to growers even though growers manage all the risks associated with growing – they should be able to manage water and the associated risks."

- "I would like to see Manitoba Agriculture provide better access to the data gathered by their whole network of weather stations and things like that. Getting that information is basically impossible. You have to pretty much email the guy and put in a manual request - they'll give it to you, but there's no online portal like the Water Survey of Canada. Manitoba Agriculture is doing great work and generating a huge amount of data, it's just not publicly available. Water quality information is also important — the water quality of Lake Winnipeg especially, because that's the ultimate sink of the province. And that data is even harder to get because it's more labour intensive and expensive to do because there's laboratory analysis and other things you have to do with that. Again, really important, but severely lacking."

"Asset management planning is an important tool that municipalities should be embracing to plan for infrastructure upgrades. But many smaller municipalities do not have the resources to maintain such a tool."

- "Manitoba's cold climate, heavy spring melt, and flat terrain create unique circumstances that often undermine the performance of best management practices imported from warmer and hillier regions. Research conducted in Ontario and the United States does not reflect Manitoban realities. Proposed best practices must be monitored and evaluated here in Manitoba, to test assumptions about performance and ensure value for money."

Focus 11

Enhance engagement and participation of Manitobans in water management

- "When you think of this from an environmental lens, are people going to be of the mind that this is a good thing, or is it a bad thing? Which camp will people fall into — are people going to say this is a positive thing for the environment? Or will it become polarized the other way, and as soon as people hear you're touching water and changing arrangements around water that the perception of a new strategy turns into a negative, whether the priorities of the strategy are fully understood or not. Just how sensitive things are around the environment provincially, and water shortages in southern Manitoba — compared to three or four years ago, this could now become a much more sensitive topic."

- "There's been some weaknesses with the provincial drainage process, which is well documented. The government did launch a new water licensing portal which expedited drainage project applications. However, there's also been weaknesses associated with the portal as well, from administrative time, increased cost and different, but still added red tape. So we've long called for the government to establish some sort of customer service standards around this."

- "It's helpful to take into account traditional and landscape based knowledge from those who are intimately familiar with managing the landscape.Sometimes policies are made in buildings where people don't set foot on the landscape, which is not necessarily very helpful to us at times. So keep consulting."

- "There's also room for far more robust types of stewardship programs to help stakeholders. You know, co-investing in how to improve water quality, water availability. I think some of those absolutely exist, but I wonder if there's room to strengthen that — government outreach to help farmers and ranchers to help them do more of that work. That helps business competitiveness as well because then you can point and say: Here are tangible actions we're taking to improve water stewardship in our supply chains."

> **"You can certainly make the case for water being an economic asset unrelated to output, because there's that socio-economic element as well: what benefits would local communities derive from investments into more robust water management? Communicating that narrative is a big piece here."**

- "When we look around at building new facilities we do our due diligence by engaging a hydrologist to make sure that we're not taking someone's allocation but rather developing around a sustainable water sources. But even then, there's still a lot of conflict and unknowns from the general populace about what that means, and what that means for their water, and how all that works. So I just foresee that being a challenge, because there's not a lot of understanding around what happens right now when someone loses their water supply, and there's gonna be a lot of extreme attitudes that come along with that."

- "Dealing with water issues is fairly reasonable because we're able to hire professionals to handle that. The water licensing process is backlogged like crazy, but it's still fairly simple and straightforward if you have the right people doing it for you; same thing with the exploration process to go find water, that's been pretty amenable for us. But from just a general perspective, for someone to try to navigate all that without the resources that we have available to us as a large company, it would probably be an overwhelming process for them."

- "When we're talking about individual producers in these different areas, their margins are slim. So some sort of financial support mechanism to assist them with implementing new technologies could be beneficial, absolutely, to provide them the opportunity to make the right decisions. Some producers, they just can't afford it — to invest $10,000 in their facility when their net profits for the year are only $9,000, it's hard to do."

- "On community education, the province has a huge opportunity to leverage the connections that watershed districts have in their local communities as an awareness tool, an education tool, and as a communications tool. Watershed districts have programming that currently exists for everything from elementary school and high school students, but also really generates engagement in the community about water management practices. Watershed districts are, and could be even more of a tremendous resource for the Province — not just their expertise, but the community leadership that they have, which is something the government could leverage in terms of community engagement."

- "A new water strategy is something that needs to be easily understandable. It needs to be clear, concise, and something that the average business owner can get access to so that they can make some of those decisions. It needs to be done from a credible source as well. And it needs to be regularly updated and prompt ongoing discussions around water-related issues."

- "The challenge in bringing together people from across the province's different and diverse communities is huge, right? The north is kind of on its own; Winnipeg is kind of on its own; rural Manitoba, there's different pockets of rural Manitoba as well. So bringing everyone together around a common issue is going to be a challenge. But if a new water management strategy is based on principles, there can be jumping off points for each part of the province based on those principles and the importance of water, which will be key. Each part of the province is likely going to have different recommendations and different solutions for how to address that."

- "If it's going to cost $1.8 billion to fix the North End treatment plant, there's surely going to be people saying: Why aren't we using that for poverty alleviation or other important initiatives? And so how do you have those kinds of conversations positively when either the failures of inaction or the benefits of action all lay out beyond the normal 4 year political cycle?"

- "I guess one way to get the public on side with paying higher rates for water would be to say, in situations where municipalities have kept very low rates but are now also running into issues with very little water: Here's how much other municipalities are paying, and show how little they're paying for water in comparison to other jurisdictions. With water quality the messaging is a little easier, because if you can bring people high quality water they're more willing to pay for it. And once it's delivered and people grow accustomed to having it that's something they'd never give up even if it costs more. However, with something like sewer systems and the back-end of the water system that the average person barely ever sees, it's harder to justify to them why millions of dollars have to be spent to upgrade it. Once water goes down the drain, customers don't think about it unless they have their own private septic systems."

- "In theory you could get users to pay fees to fund some of this work on improving wastewater facilities, but part of the problem is that the City of Winnipeg and the Province have no way of measuring wastewater output right now. And unless you can measure what an individual user is actually producing in wastewater and contributing to the system, it's not going to be easy. Right now, in calculating what users pay, the only thing that is measured right now is water consumption — what you put back into the system in the form of wastewater is not measured. The City knows what's going into the entire system, but they don't know individual contribution levels to that. For individuals and businesses to say yes, we're prepared to invest in a user pays system, you're going to need to be able assess that and demonstrate to users that they are indeed paying for what they're contributing to the system. Right now, I don't think they can. So the answer is yes, users should be paying more for water, but there's a whole bunch of things that need to be done first in order for that to be a reasonable ask."

"So more than ever, people who believe that we all need to contribute something to sustainability will be watching with a finer tuned eye to say, "Does this make sense? Is somebody abusing whatever policy privilege has been provided to them through access to water or license? Is what we're doing really in the best interest of the big picture of where water should be?"

A community-based monitoring volunteer collects a water sample at Cooks Creek for analysis of phosphorus concentration. *Photo: Paul Mutch*

- "The emphasis on getting local governments to inventory their natural assets and, at least at a qualitative level, understanding the value of natural assets has helped to really move parks and wetlands out of just the recreational conversation into some of the more mainstream core asset services conversation. This has to be done in a very cross-departmental kind of way; it can't just be left to a small group, unless it's handed to finance and a core group that comprises an asset management team. It can't be siloed off into the parks department, or something like that. As people keep moving forward and try to implement the valuation of natural assets it is an uphill battle as people try to come to grips with thinking about nature this way. It's asking for a lot of ripple effect changes."

- "We will need to overcome the reluctance to use citizen-generated data by Manitoba's provincial government. Encouragingly, we now see the federal government publicly recognize the value and credibility of citizen-generated data for water protection. We continue to engage with provincial and federal government monitoring agencies to recognize the strength of citizen-generated phosphorus data – collected from dispersed locations in response to highly local flooding and rain events. That's tough data for a centralized government agency to collect cost-effectively. Citizen monitoring is also driven by incredibly strong public interest. So many Manitobans are seeking tangible ways to contribute to water solutions. They embrace the opportunity to collect this information that is so necessary to support better water decisions."

"If you can cultivate this public mindset that says we are in transition between a sub-humid ecosystem and a semi-arid ecosystem, our culture will transition as a result, just like it already is in so many other ways."

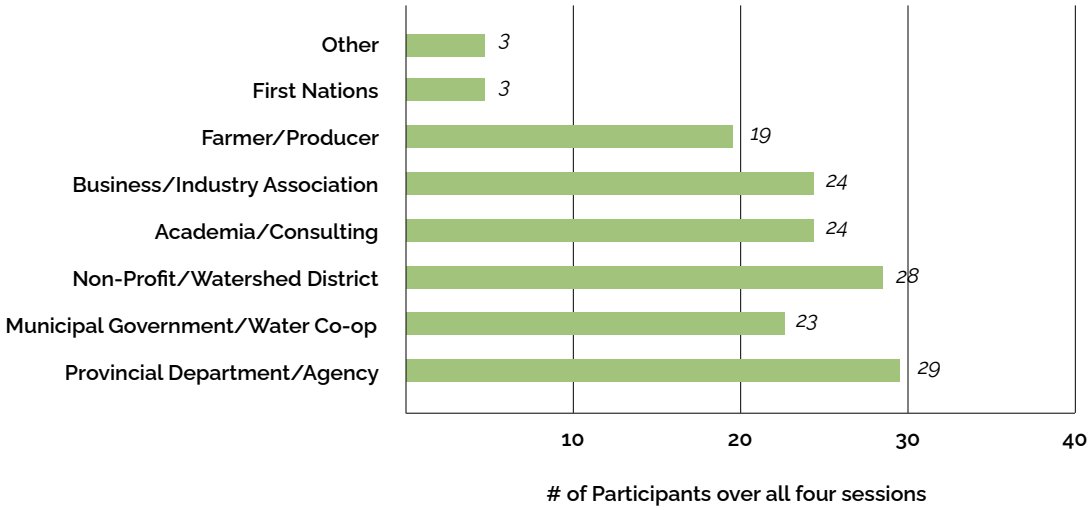
- And more than ever, somebody may debate whether this is appropriate or not – and somebody who lives in downtown Winnipeg will believe they have a right to comment on what the province is doing in conservation throughout the province. And if they're paying taxes, yes, they do have that right. I can see lots of farm guys putting their arms up and say, "They don't know anything about my farm. They should have nothing to do with it." That's not the world we live in anymore, and it probably never should have been

Group Engagement Sessions

Throughout January 2022, EMILI organized virtual group engagement sessions around the four key theme areas mandated by the Province – agriculture and agri-food, community and economic growth, environment and ecosystems services, and infrastructure and resilience.

The sessions were facilitated by Winnipeg-based market research firm, Prairie Research Associates, with discussion questions for participants developed with input from key government staff.

Participant Breakdown by Sector



Questions Asked at All Sessions

Quantitative	Qualitative
How important would you rank the importance of creating a new standalone provincial agency to deal with water issues in Manitoba?	What would signify that a Manitoba water management strategy is successful, and what metrics should be used to track that success?
How likely is it that your business will be negatively affected by water-related issues within the next 2-3 years?	How can the Government of Manitoba balance the protection of our waters and the environment with the need for economic development and growth?
What do you feel is the greatest threat to sustainable water management in Manitoba?	What types of water related information and data does your business/organization need to make decisions?
_____	What are your top three other priorities or issues that you would like a water strategy to address?

Common points of feedback:

- Manitoba is being reactive instead of proactive when it comes to water needs. In particular, if rural municipal water systems are not provided with greater assistance to enhance their water supply, industries will set up in other jurisdictions and Manitoba will lose out on jobs, investment, and growth.

- Manitoba does really well with flood control but is ill-prepared for drought. Flood protection and drought protection strategies need to be better integrated to create synergistic benefits.

- A more coordinated approach to water drainage and usage between the province, municipalities, and communities is necessary. A central provincial water agency may be necessary to help coordinate the plans, develop financing strategies, and bring together interdisciplinary expertise, including Indigenous knowledge and local knowledge specific to that bio-region. Provincial representatives should sit down and work hand-in-hand with municipalities at the beginning of every year to map out drainage plans to limit negative downstream effects.

- Priorities vary across the province. A new water strategy should account for regional differences, and the needs of different regions in the province, with clear short-term and long-term milestones that are communicated to stakeholders and the public. Goals need to be measurable to gauge progress, and they must make it clear that effective water management can provide shared benefits equally to communities, agriculture, and the environment.

- Provincial water data needs to be more widely collected, and made publicly available through some form of open data interface. This platform should host both provincial data – to be bolstered with more on-the-ground data collection and monitoring – and also include information from both the federal government and other authorities, such as Water Survey of Canada flow data and Environment Canada meteorological data.

- The government needs to establish/update its baselines for the total available water in the province and in each region, including underground flows and recharge, and how this will be impacted by climate change. This would assist with decision-making around the allocation of this available water between the domestic, agriculture, and industrial sectors; and possibilities for connecting the water supplies across Manitoba regions through a system of networked water storage and distribution.

- Priorities within a new water strategy need to be aligned as much as possible with the key focus areas of both the Canada Infrastructure Program and the Canadian Infrastructure Bank to attract federal funding for large engineered projects as well as protection/expansion of nature-based solutions, like wetland protection. Currently, the province does not have the funds to make all the needed investments on its own.

- Tax incentives can be a powerful tool for water management, but at present they are applied inconsistently. For example, an earthen lagoon is exempt from taxes, but a marsh or a natural pond is taxed. Farmers should be encouraged to retain water and protect marshland on privately-owned land, which in most places has a production value of $8,000 to $10,000 an acre. Until there is an economic benefit, such as a tax incentive, there will be nothing to encourage a farmer taking land out of production to maintain or restore wetlands.

A combine cutting through an oat field near Roblin, Manitoba, September 2020.
Photo:Maggie Funk/Shutterstock

Agriculture and Agri-food

January 13, 2022

Panelists

1. Ray Bouchard, EMILI Board Chair and CEO of Enns Brothers Ltd.
2. Dan Sawatzky, General Manager, Keystone Potato Producers Association
3. Dennis Janzen, Owner/Operator, Janzen Farms

Key Input from Participants

- If Manitoba can enhance water supplies, market opportunities exist in the form of increased canola crushing, hog industry expansion, meat processing, production of biofuels, and crop diversification toward higher value items, such as potatoes, vegetables and strawberries.
- Expanding irrigation capacity can also serve as a means of drought mitigation for both traditional and high value crops by connecting growers to water supply during key times of the growing season even amid excessive lack of moisture, while also leading to an overall reduction in the water used per unit of crop produced.
- In the past, Manitoba has done a good job at getting water off of the land, but now we need to think about our relationship with water from a closed loop perspective: taking the water off the land; holding it in a variety of ways; and then putting it back on the land when needed.
- Added effort should be made to encourage sustainable tile drainage projects. With more tile drainage in rural municipalities and more water flowing into the ditches recently, RMs are instead now trying to encourage farmers to detain and retain water on their property.

- With the coming pressures from climate change, Manitoba will need to take steps to ensure that promises made to attract industry are able to be kept while maintaining water levels for municipalities. One should not come at the cost of the other.

- At present, nearly all the water rights in potato growing regions are fully utilized. Any future development or expansion will depend on future water development. At the same time, Manitoba is producing more potatoes now than in 2003 with less farmers and less acreage, showing how irrigation allows the industry to become more sustainable.

- More extensive data mapping of elevations across agricultural fields can help reveal the slope of land to create better drainage plans designed to collect and manage surface water in central reservoirs in times of moisture excess. These reservoirs could then provide water for use in irrigation or as a feeder system for municipalities in times of drought.

- There should be more focus on managing runoff and retaining snowmelt and rainfall on the agriculture landscape by increasing organic matter in the soil – for example, through including alfalfa in crop rotations – and through wetland restoration. These techniques bring benefits for crop and cattle producers.

- On the topic of water quality and re-use of water, differing views were presented. The agriculture sector needs to be open to new technology and emerging methods that will help it use poor quality water (brackish water) and/or reuse water to supplement the water supply. Producers are no longer prepared to use non-potable water to mix with their chemicals to spray their fields. The chemicals are too expensive to risk by using poor quality water that plugs up their spraying equipment. While farmers were initially reluctant, because of the cost, to use treated water to feed their hogs, they found that high quality water equals high quality hogs that are healthier and fatter. Now farmers want a consistent high quality water source.

- Groundwater sources can be an effective buffer against short term droughts, as they are not necessarily affected by one or two dry years. Money should be allocated to conduct studies to identify alternative sources while also updating the government's understanding of limitations on existing groundwater sources – volumes, underground flows, and recharge rates. Developing enhanced recharge infrastructure should be part of the new strategy.

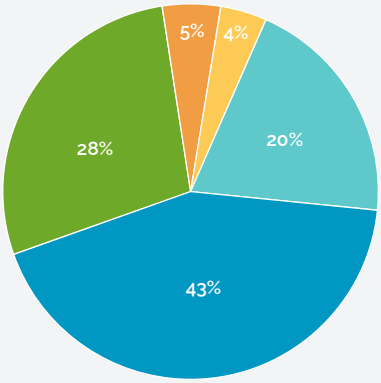
- Measures of a successful strategy from an agriculture perspective include: no increase in brackish water volume; increases in irrigated land acreage; a reduction in the water used per unit of crop produced; increase in population having access to potable water, but a reduction in per capita water usage; an increase in the water storage capacity; reduction in flood and drought damage to producers; increases in square metres of provincial water storage; added hectares of new protected habitats; kilograms of phosphorus phyto-extracted from water sources.

- Effects of drought on livestock should not be overlooked. Producers are losing generations of pedigree animals to the auction market prematurely due to lack of water, which they will never recover. Prices of inputs are increasing dramatically around feed for cattle. As a mitigation against drought, cattle producers are going to have to have an extra year of feed held in reserve. Moreover, the dairy industry is committed to a certain production level every day – any water restriction means those levels cannot be met, so there is no way to shift production in a drought.

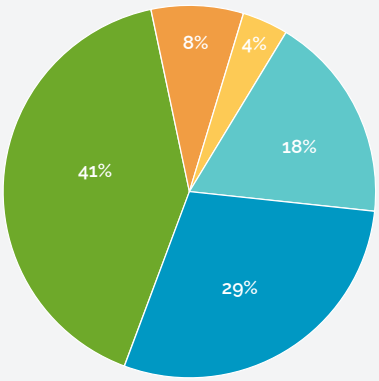
- For many farmers, the need to increase the use of high quality water is not a choice but now a food safety standards requirement. Having water that is tested and certified as high quality for animals is becoming the standard. Water for animals used to come from a slew, now it needs to be tested or come from the municipal supply; municipal demand for quality water will keep growing and continue to strain aquifers and the existing infrastructure.

Poll question 1:

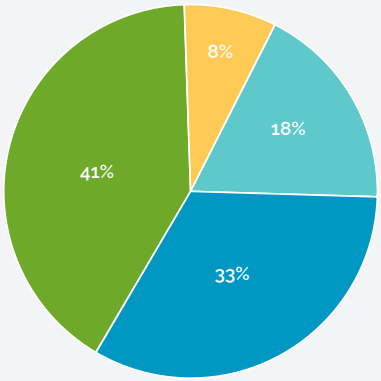
How important would you rank the importance of creating a new standalone provincial agency to deal with water issues in Manitoba?



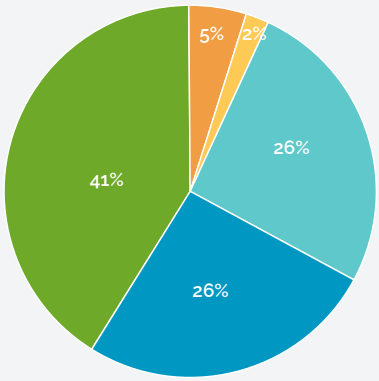
Combined Results



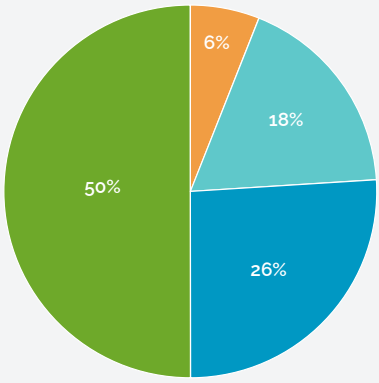
Agriculture Session



Econ Growth Session



Environment Session



Infrastructure Session

Community and Economic Development

January 19, 2022

Panelists

1. Chuck Davidson, President and CEO, Manitoba Chambers of Commerce
2. Margot Cathcart, CEO, Rural Manitoba Economic Development Corporation
3. Greg Archibald, CEO, Pembina Valley Water Cooperative

Key Input from Participants

- Manitoba has a relative abundance of water overall, but water is not always in the right place. Future economic growth will rely on developing an ability to move water from areas of large supply to areas of short supply. There are tremendous economic development opportunities in the Pembina Valley area, for example, but these opportunities are being stifled and investment is being lost due to a lack of water.

- Businesses are looking at making decisions as to whether they can expand here, but to do so they first need to know what our water capacity is. There are also businesses in areas of Manitoba that are potentially looking outside the province because of the challenges with water here.

- Government needs to provide more support for businesses to help them navigate legal, regulatory and procedural requirements around water licensing and use, and water project approvals. Most businesses don't have the time to figure out how to progress their projects and ideas through the government.

- Incorporating an integrated watershed management plan alongside economic development and community development is key. Utilizing the principles of integrated watershed management planning means looking at the entire course of the watershed and considering those upstream and downstream effects. This approach will help provide some balance to both the protection of ecosystems, while still incorporating sustainable economic development and growth.

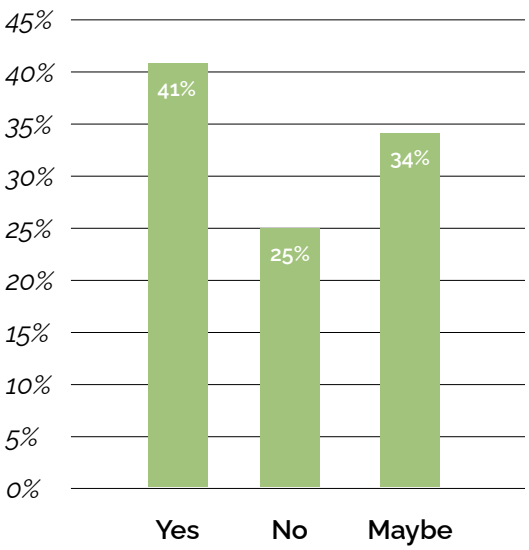
- Metrics of success from an economic growth perspective include: when ecosystem needs – such as the timing of water inputs, volume requirements, water quality health, biodiversity support for our lakes, rivers and wetlands (including fish populations) – can be met and maintained while providing the water needs for economic development and business. Other helpful metrics would be the amount of money accessed from the federal government for water management activities and the turnaround timeline to get that money.

- When it comes to municipal infrastructure and regional water systems, there just aren't enough infrastructure dollars currently available. Any new water strategy for Manitoba needs to be backed by significant amounts of money to jumpstart its implementation. Too often strategies lack real programs, money, or processes attached, undermining both the strategy's effectiveness and public confidence in the government's ability to manage the issue.

Rural Manitoba Economic Development Corporation: Municipal Survey, 2022

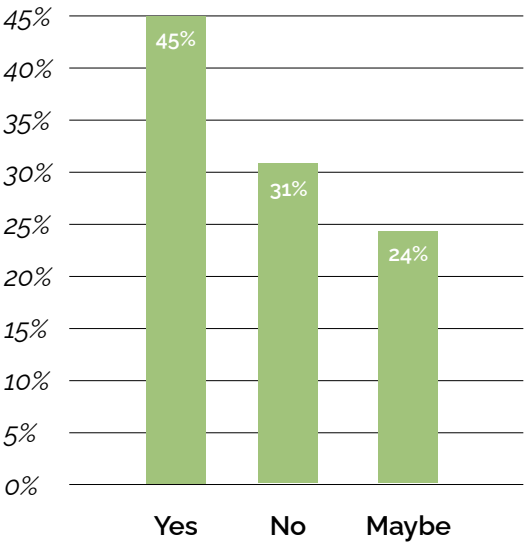
Question 1:

Does your municipality have the water capacity it needs to attract new economic development projects?



Question 2:

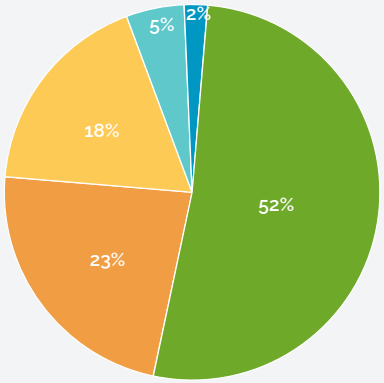
Do you have adequate water infrastructure in your community to support economic development?



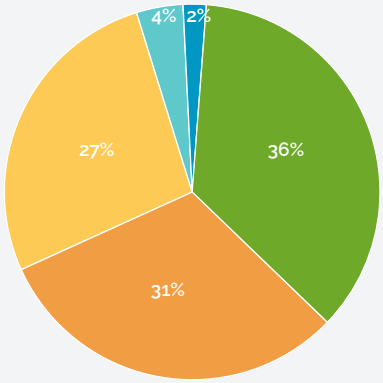
- The pricing of water needs to be adjusted to reflect its true value. Municipal water has historically been severely underpriced, meaning users have taken it for granted and had an underappreciation for the need to conserve water. A peak usage demand structure could be used to help manage demand: other jurisdictions have pricing models that require customers who use water during high demand times to pay more.
- To better tap into federal money for water and infrastructure projects, the provincial government should look at taking a bigger role in working with municipalities. If the province owns the asset, the federal government will contribute 50% of the project budget. If the provincial and municipal government make a joint request for funding, then the federal government will contribute 40%. Therefore, the less active or ownership-oriented the province chooses to be in terms of water-related projects, the less money municipalities will receive from the federal government.
- As climate change and residential population growth and business expansion all increase in parallel, demand is going to change over time. Demands for water resources are likely to increase the strain on existing (and new) infrastructure, requiring larger raw water storage, larger treatment facilities, and an increased investment in asset preparedness.

Poll question 2:

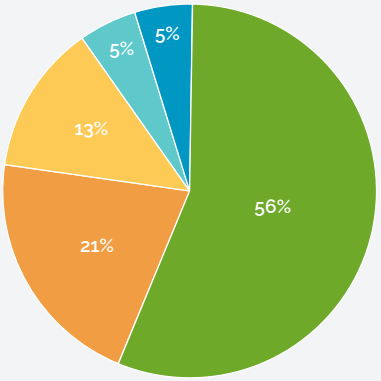
How likely is it that you (your community, business, environment) will be negatively affected by water-related issues within the next two to three years?



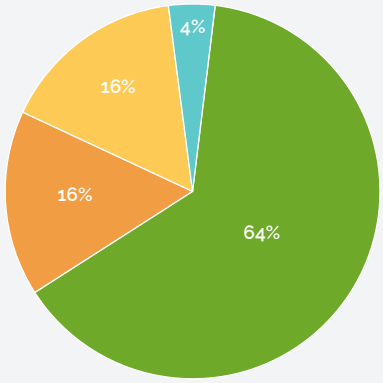
Combined Results



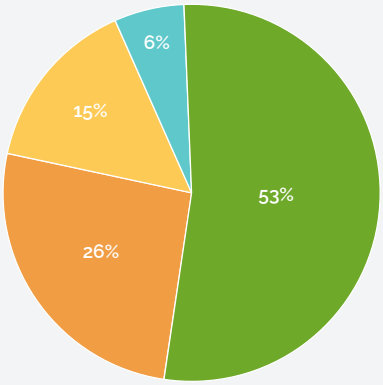
Agriculture Session



Econ Growth Session



Environment Session



Infrastructure Session

Environment and Natural Infrastructure

January 25, 2022

Panelists

1. Stephen Carlyle, CEO, Manitoba Habitat Heritage Corporation
2. Lynda Nicol, Executive Director, Manitoba Association of Watersheds
3. Jennifer Van de Vooren, environmental specialist with the Coordinated Aquatic Monitoring Program (CAMP)

Key Input from Participants

- Creating a new water strategy provides the province with a great opportunity to better integrate water monitoring networks around water quality and aquatic ecosystem health.

- Establishing protected areas is a nature-based solution. The Manitoba Protected Areas Initiative could enhance work in this area by helping to identify areas that are well suited for nature-based solutions, while also working with land developers and agricultural producers on initiatives like restoring wetlands or expanding cover cropping.

- The northern districts are rich with peatlands, which hold co-benefits in terms of carbon storage while at the same time filtering water and improving the downstream water quality. The province should take an inventory and determine which peatlands should be conserved so their carbon stays in the ground. This would represent a major contribution by Manitoba to helping mitigate global climate change. Presently, most of those peatlands are not agricultural lands, but still are threatened by increasing wildfires in northern Manitoba.

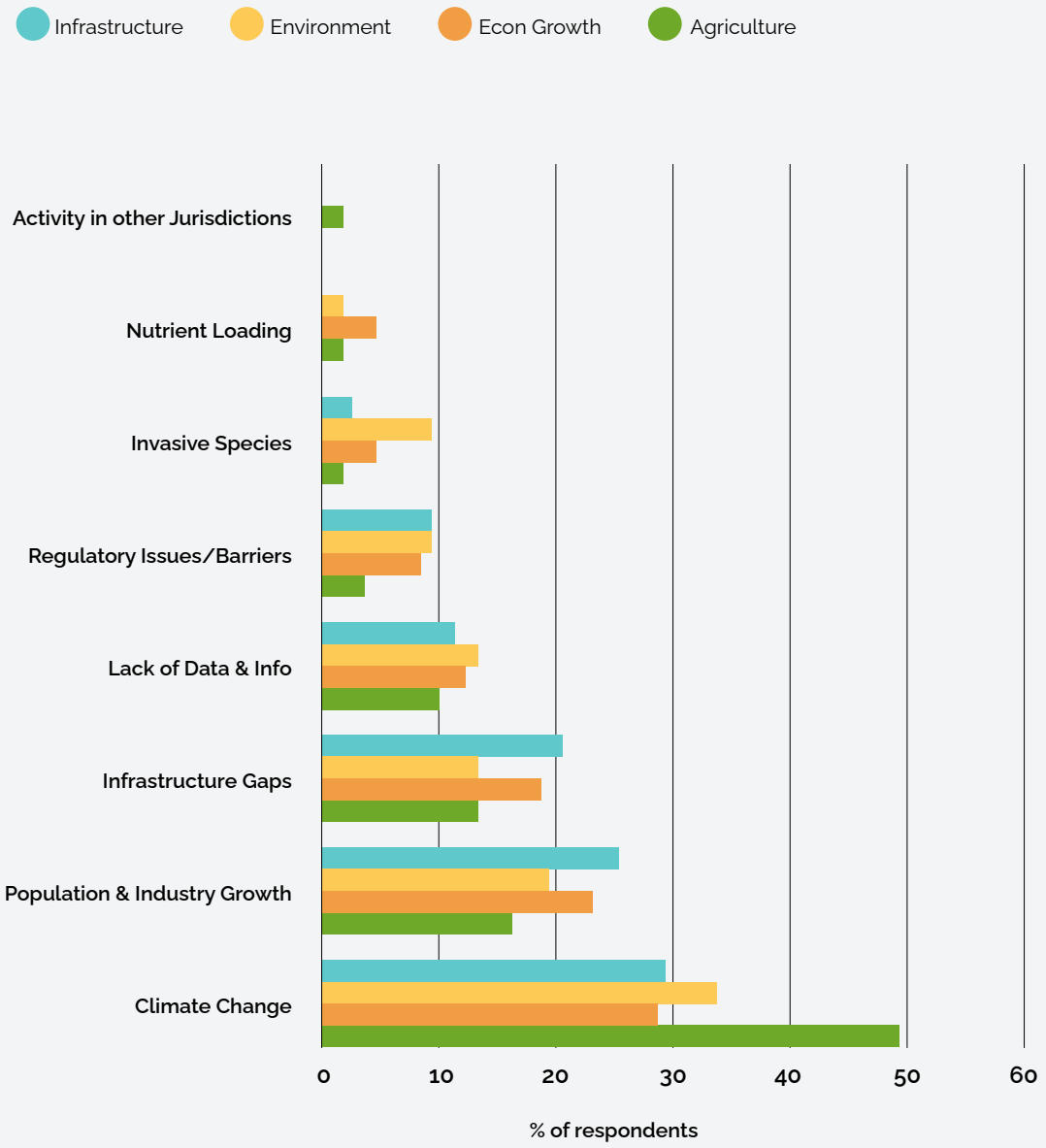
- The province should shift its emphasis and support to comprehensive large-area land use planning within the watershed districts to create a balance on the landscape, so nature, economic, cultural, and social values are considered.

- Metrics of success from an environmental perspective include: a bounceback in endangered and at-risk species populations around lakes, rivers and wetlands over time; high quality potable water available for all communities; reduction in frequency of toxic algae blooms in provincial waterways; and improvement in general aquatic habitat health. In some cases there may not be significant change in outcomes around these for many years, but they should still provide signals the strategy is going in the right direction.

- There needs to be serious targeted messaging to inform the public and increase broader understanding among Manitobans around provincial water issues. Investment into developing a range of communications options for audience-based and values-driven messaging may be an effective use of funds. Part of this might include ways to integrate water into different subject areas within school programming in K-12 education. Topics could include hydrology, ecology, history and social dynamics around water in Manitoba, with a large component of hands-on learning outside of the classroom to learn more about provincial hydropower and water sources. The intention would be for these messages to then filter through to parents in the home.

Poll question 3:

What do you feel is the greatest threat to sustainable water management in Manitoba? (Responses grouped by session)



Infrastructure and Resilience

January 27, 2022

Panelists

1. Dave Sauchyn, Director of the Prairie Adaptation Research Collaborative at the University of Regina and Professor of Geography and Environmental Studies
2. Jeff O'Driscoll, Division Manager, Infrastructure, Associated Engineering
3. Roy Brooke, Executive Director of the Municipal Natural Assets Initiative

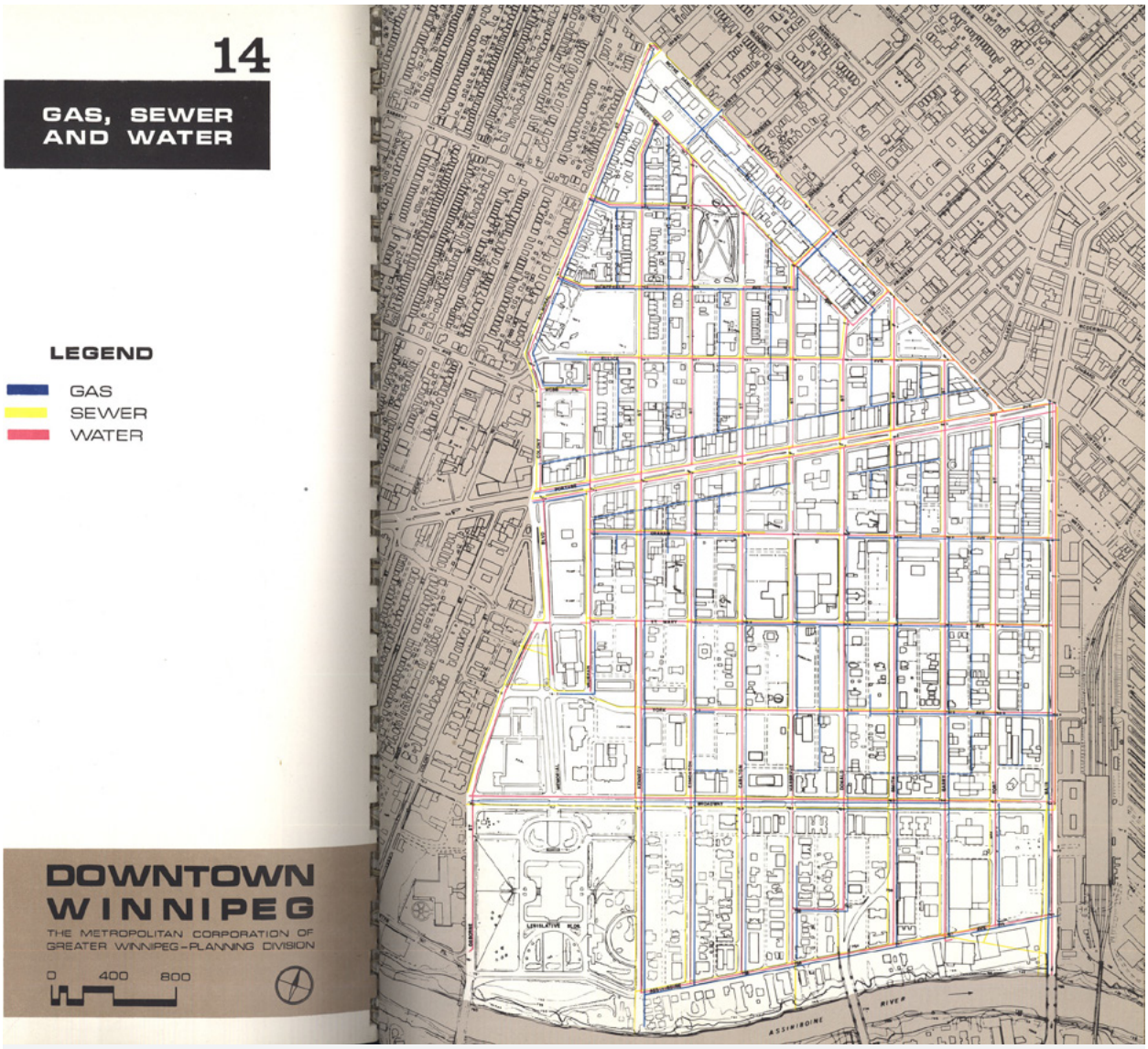
Key Input from Participants

- Infrastructure aspects needed for economic and population growth are all intertwined – hydro generation and delivery, natural gas pipelines, etc. If we solve the water availability for producers and processors, but as a result cannot meet hydro demands, then we have just created another problem. Water provides a good starting point to start coordinating all other types of infrastructure needed for growth.

- Population growth does not necessarily translate directly into increased water demand. Old consumption patterns do not necessarily predict future residential demand for water. As the provincial population grows and moves into new housing stock with water efficient plumbing, we will continue to use less per capita. If older residential stock was encouraged to upgrade its plumbing, we would see an even greater reduction in per capita use.

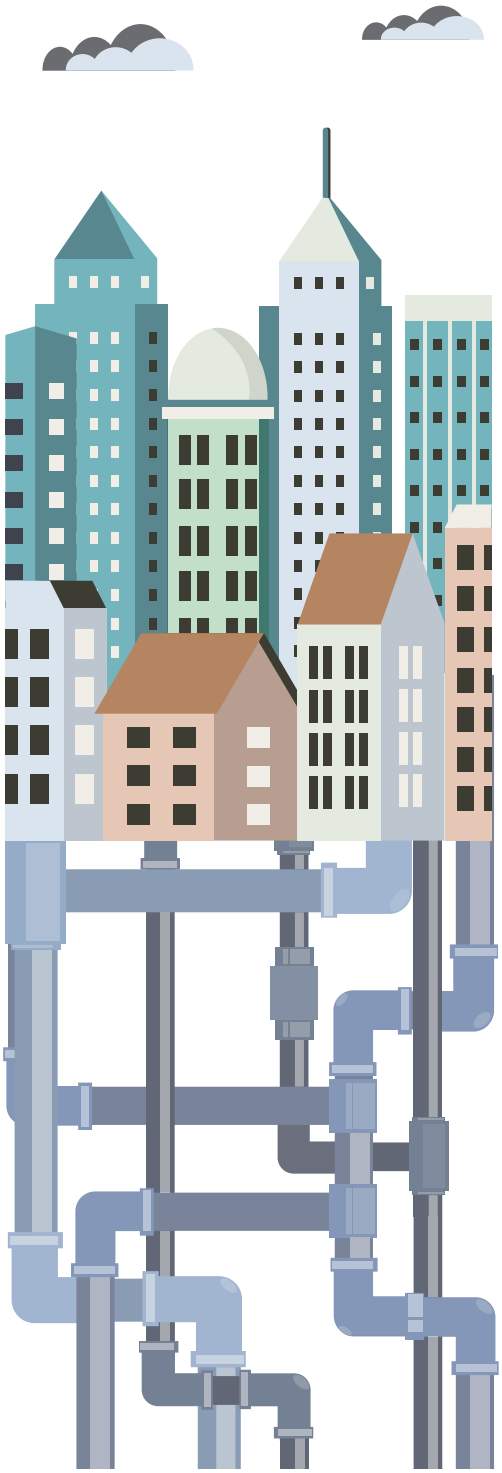
- However, it is not just residential housing alone that we need to consider but the growth of the services needed to support that development – restaurants, schools, hospitals, recreation centers and more. Going forward, these developments are going to bring added stress to the water supply.

- Of the expansion of the population over the next 20 years, a large percentage of that growth will occur in Winnipeg and in communities surrounding the Perimeter. For a lot of these communities, their water resources are already stretched. In many cases, they are going to need assistance to expand their water handling facilities and pipelines. A lot of these communities don't have a storm sewer system, so if we have excess moisture coming more frequently, they don't have the infrastructure to handle those sharp, sudden downpours that can occur during the summer.



A gas, sewer and water map of downtown Winnipeg from the city's planning division in 1969. Most of Manitoba's water infrastructure has not been upgraded in decades. *Source: Government of Manitoba*

- Population growth is also not just about the number of people who need water, but the fact that the ability of the land to absorb water has been reduced. With increased population will be the temptation to increase development on flood-plains, which will further exacerbate flooding and the damage it does. People moving into a more concentrated area, plus the effects of having more of these rain events and rapid snow melt, is of great concern and needs to be addressed in any water strategy.
- The capital cost and ongoing costs of traditional engineered approaches can be several times more than what needs to be spent to upgrade and maintain natural assets. New residential developments often start by scraping away the landscape and then considering what to build back to provide common services, like retention ponds for stormwater management. In many cases it's viable for developers to retain existing assets like storm water systems, native grassland, remediation and restoration of altered landscapes, riparian zone restoration, green roofs, and wetland solutions. There are Manitoba companies that can already provide these services, saving the cost of developing them from scratch.



- A natural assets inventory is something that could be considered. Natural assets are part of any water strategy and we need a map that shows where these natural assets are. Such an inventory will identify the assets within a jurisdiction, the condition of those assets, and some of the risks that they face. Those three pieces of information will help prioritize future natural asset management strategies and where to focus resources. Once the inventory is done, it is possible to undertake modeling to understand the services provided by these natural assets and investigate the impacts if, for example, a wetland is restored. People start to connect high-level biodiversity green space strategies with more tactical and operational plans.

- More investment by the provincial government in key areas may be necessary to support what is trying to be achieved with the water management strategy, particularly in the reduction of the number of gauging stations on water bodies in terms of level and flow. And the same is true for ground-water aquifers; the amount of data that's being collected has decreased. Manitoba still has the same provincial agencies, but they are not staffed at the levels as they used to be – for good data collection, (human) resources are key, and often something municipalities are not resourced adequately for.

- Provincial infrastructure was not designed for impending challenges related to climate change. As these increase, the design of the existing infrastructure is not going to meet the province's needs, and the age of much of the province's infrastructure puts it at a greater risk of failing. Drinking water systems and drainage systems will be among the most stressed aspects of infrastructure. The overloading of drainage systems has the potential to impact road systems and housing as well.

- The Assiniboine dikes are over 70 years old and are in need of major repairs. They are in extremely poor condition and may not last through another major flooding event without some major repairs, or being totally rebuilt in many sections. This is a priority that must be fixed ahead of another major flood episode.

Manitoba Government Public Engagement Summary

In conjunction with EMILI's work to support the government's new provincial water management strategy, the Province of Manitoba launched its own engagement activities in 2021-2022, gathering insights from both members of the public and Indigenous communities.

Below are highlights from the EngageMB Survey conducted during July 2021. As of Spring 2022, the Government of Manitoba's consultation process with Indigenous stakeholders was still in development.

EngageMB Public Survey

Public engagement on water management included a survey and idea board that were open for feedback from July 13 to Aug. 23, 2021. The department also invited industry organizations, non-governmental organizations and other stakeholders to participate via email and requested they raise awareness with their own membership. Facebook and Twitter were also used to promote additional participation in the engagement.

A total of 457 responses were received, with 83 percent of respondents agreeing that the proposed vision statement – "Manitoba is home to resilient, healthy waters that support thriving ecosystems, communities and economies for generations" – captured the most important elements regarding the future of water in Manitoba.

Of the nine guiding principles for a new Manitoba Water Management Strategy proposed by the Expert Advisory Committee, respondents ranked "protect the quality and quantity of surface and groundwater" and "ensure a basis in science and evidence" as the two most important principles.

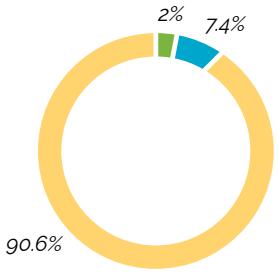
Unique suggestions for added guiding principles

- Focus resources towards advancements in technology and education on the current state of our water resources.
- Improve data sharing, analysis and collection across inter-provincial and international boundaries to improve planning and preparedness for the future.

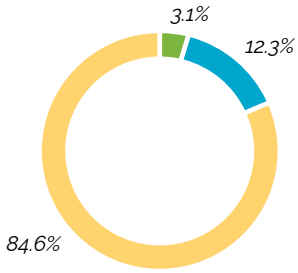
EngageMB Survey - Question:

Please identify the level of importance you place on each of the proposed guiding principles:

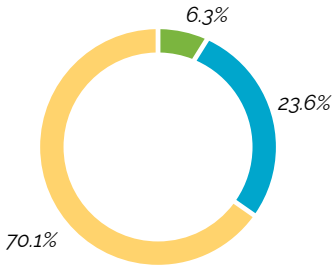
Protect the quality and quantity of surface and groundwater



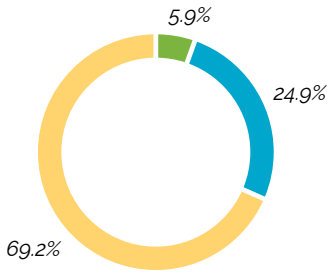
Ensure a basis in science and evidence



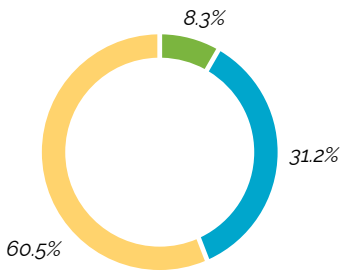
Link land and water planning



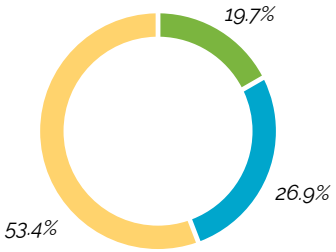
Plan for long-term with short-term milestones



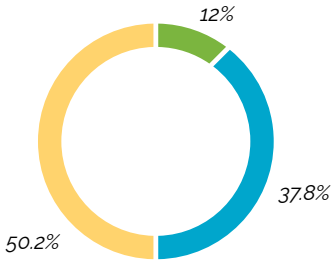
Define roles and responsabilities



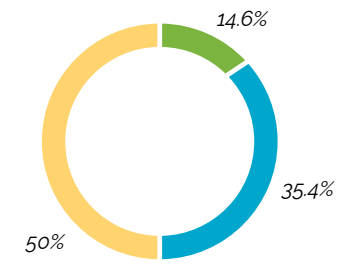
Ensure Indigenous participation and respect for traditional knowledge



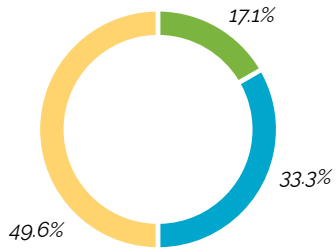
Utilize watershed and basin boundaries



Encourage the involvement of all Manitobans



Support economic development and address water-based limits to growth



Respondents were also asked to indicate their level of agreement with the Province's 11 proposed focus area statements. The top four focus area statements that received the most positive ratings were:

1. Improving surface water quality
2. Protecting biodiversity and supporting aquatic ecosystem health
3. Building our resilience to a variable and changing climate
4. Increasing our understanding of groundwater supply and quality and its interrelationships with other parts of the environment

Lake Winnipeg near Camp Morton, Gimli MB *Photo: lastdjedai/Shutterstock*

Unique comments, suggestions and ideas

- Use geospatial and engineering technology to improve water supply allocation planning and decision-making.
- Engage Indigenous peoples in water management through involving them in watershed district planning and establishing an Indigenous water advisory panel.
- Consolidate the provincial government's water management functions together in a single area to help make it easier to resolve disputes over water use.
- Make water data more accessible to community members, industrial developers and provincial experts by creating a centralized water data hub, and create a clear plan for coordinating water-related data sharing, analysis and collection with our provincial, national, and international partners.
- Develop new crops adapted to a changing climate to support sustainable food production.
- Manage, capture and store water on farmland through tools such as irrigation scheduling, controlled (tile) drainage, engineered wetlands and consolidating existing wetlands.
- Increase investments in regenerative agriculture.
- Align water management strategies and aquatic systems management with greenhouse gas emission targets; opportunities for this exist at both the regulatory and ecosystem management levels.
- Recognize that recreational use of Manitoba's waterways are vitally important, but can also increase pollutants and damage shorelines
- Invest in wastewater management infrastructure, and promote circular economies through the reuse of wastewater and greywater through changes to the Manitoba Building Code.
- Allow riparian zone vegetation to flourish, creating wildlife and fish habitat in drains where agricultural potential is low.
- Build small dams (holdbacks) in escarpments where gullies form a natural reservoir.
- Include water studies in elementary through post-secondary curriculum. Make it part of curriculums for kids to understand where their water comes from, where it goes and what happens to it along the way.
- Enhance watershed education and outreach to build awareness; use public messaging campaigns to increase knowledge of water conservation practices that individuals and communities can adopt.
- Use organizations conducting community-based monitoring and citizen science research to fill in key gaps in current monitoring programs, such as water quality.
- Complete a wetland inventory

Conclusion

This report is based upon one year's worth of extensive stakeholder and expert engagement, significant foundational research and analysis, and the outcomes of three strategic water projects – each project a collaboration between key government staff and one of the world's leading water-focused engineering firms.

Its submission also comes at a time when the intertwined dynamics of climate change, domestic and global market opportunities and municipal population growth demand a new, holistic provincial water management strategy to protect Manitoba's environment and bolster economic prosperity into the future.

With that in mind, the recommendations contained in this report are respectfully submitted to the Minister of Environment, Climate and Parks for consideration, and to inform the Province of Manitoba's work in creating a new, forward-looking water management strategy that will ultimately provide both short and long-term benefits to all Manitobans.

References

1. Expert Advisory Council to the Minister of Conservation and Climate. January 2021. Recommendations for a Provincial Water Management Strategy for Manitoba. Retrieved July 7, 2021. (https://www.gov.mb.ca/asset_library/en/eac/eac_recommendations.pdf)

2. Waldman, Ben. 2019. "New policy will ensure no net loss of wetlands: province." Winnipeg Free Press, October 4. Retrieved August 28, 2021. (https://www.winnipegfreepress.com/business/agriculture/new-policy-will-ensure-no-net-loss-of-wetland-benefits-province-562144352.html)

3. Stevenson, Lorraine. 2018. "New law aims to protect wetlands, lakes, rivers." Manitoba Co-operator, June 14. Retrieved August 28, 2021. (https://www.manitobacooperator.ca/news-opinion/news/new-law-aims-to-protect-wetlands-lakes-rivers/

4. Province of Manitoba. August 12, 2021. "Canada and Manitoba renew commitment to protect Lake Winnipeg and its basin." Retrieved August 12, 2021 (https://news.gov.mb.ca/news/?archive=&item=52122)

5. Expert Advisory Council to the Minister of Conservation and Climate. January 2021. Recommendations for a Provincial Water Management Strategy for Manitoba. Retrieved July 7, 2021. (https://www.gov.mb.ca/asset_library/en/eac/eac_recommendations.pdf)

6. Province of Manitoba. July 22, 2021. "Low precipitation and water levels advisory." Retrieved July 22, 2021. (https://news.gov.mb.ca/news/index.html?item=51839&posted=2021-07-22)

7. Blaze Baum, Kathryn. 2021. "The plants looked as if someone took a blowtorch to them: Relentless heat is scorching crops across Western Canada." The Globe and Mail, July 16. Retrieved July 16, 2021 (https://www.theglobeandmail.com/business/article-the-plants-looked-as-if-someone-took-a-blowtorch-to-them-relentless/)

8. Staff author. 2021. "Morden restricts water usage as southern Manitoba city declares extreme drought." CBC News, July 27. Retrieved July 27, 2021. (https://www.cbc.ca/news/canada/manitoba/city-of-morden-extreme-drought-1.6119759)

9. Klowak, Marianne. 2021. "Manitoba municipality declares state of agricultural disaster due to drought, record-breaking heat." CBC News, July 6. Retrieved July 27, 2021. (https://www.cbc.ca/news/canada/manitoba/st-laurent-agricultural-disaster-drought-heat-wave-wfpcbc-cbc-1.6091120)

10. Province of Manitoba. November 29, 2021. "Province investing in water infrastructure to support needs in Morden and region." Retrieved November 29, 2021. (https://news.gov.mb.ca/news/index.html?item=52785#)

11. Durrani, Temur. 2021. "Drought forces Holiday Mountain ski resort to cancel season." Winnipeg Free Press, August 9. Retrieved August 16, 2021. (https://www.winnipegfreepress.com/arts-and-life/life/greenpage/drought-forces-ski-resort-to-cancel-season-575065212.html)

12. Laychuck, Riley. 2021. "'Challenging times': for Manitoba farmers as drought persists." CBC News, July 7. Retrieved July 25, 2021. (https://www.cbc.ca/news/canada/manitoba/manitoba-drought-cattle-farmers-1.6093799)

13. Seskus, Tony. 2021. "How this summer's drought could have you paying high beef prices again next year." CBC News, August 13. Retrieved August 13, 2021. (https://www.cbc.ca/news/business/canada-beef-prices-drought-1.6137777)

14. Province of Manitoba. August 10, 2021. "Manitoba supporting producers affected by drought with $62 million investment in agrirecovery." Retrieved August 10, 2021. (https://news.gov.mb.ca/news/index.html?item=52077)

15. Steve Miller, Kenn Chua, Jay Coggins, Hamid Mohtadi. October 2021. Heat Waves, Climate Change, and Economic Output. Journal of the European Economic Association, Volume 19, Issue 5, Pages 2658–2694. Retrieved November 5, 2021. (https://doi.org/10.1093/jeea/jvab009)

16. IPCC, 2021: Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [Masson-Delmotte, V., P. Zhai, A. Pirani, S.L. Connors, C. Péan, S. Berger, N. Caud, Y. Chen, L. Goldfarb, M.I. Gomis, M. Huang, K. Leitzell, E. Lonnoy, J.B.R. Matthews, T.K. Maycock, T. Waterfield, O. Yelekçi, R. Yu, and B. Zhou (eds.)]. Cambridge University Press. In Press. (https://www.ipcc.ch/report/ar6/wg1/downloads/report/IPCC_AR6_WGI_Citation.pdf)

17. Bush, E. and Lemmen, D.S., editors (2019): Canada's Changing Climate Report; Government of Canada, Ottawa, ON. Retrieved July 27, 2021 (https://changingclimate.ca/)

18. Province of Manitoba. September 14, 2021. "Manitoba wildfire service thanks firefighters from South Africa for efforts on front lines of Manitoba fires." Retrieved September 14, 2021. (https://news.gov.mb.ca/news/index.html?item=52457)

19. Kives, Bartley. 2021. "Drought lowers river levels to the point where Manitoba Hydro expects $200M deficit." CBC News, November 10. Retrieved November 10, 2021. (https://www.cbc.ca/news/canada/manitoba/manitoba-hydro-deficit-2022-1.6244600)

20. Sauchyn, D., Davidson, D., and Johnston, M. (2020): Prairie Provinces; Chapter 4 in Canada in a Changing Climate: Regional Perspectives Report, (ed.) F.J. Warren, N. Lulham and D.S. Lemmen; Government of Canada, Ottawa, Ontario. Retrieved July 27, 2021. (https://changingclimate.ca/site/assets/uploads/sites/4/2020/12/Prairie-Provinces-Chapter-%E2%80%93-Regional-Perspectives-Report-1.pdf)

21. Province of Manitoba. August 20, 2021. "Province issues overland flood warning for areas in southwest Manitoba and parts of the Interlake region." Retrieved on August 20, 2021. (https://news.gov.mb.ca/news/index.html?item=52153)

22. Staff author. 2021. "Friday's downpour breaks decades-old rain record in Winnipeg, leaving some homes damaged." CTV News, August 21. Retrieved on August 26, 2021. (https://winnipeg.ctvnews.ca/friday-s-downpour-breaks-decades-old-rain-record-in-winnipeg-leaves-some-homes-damaged-1.5556234)

23. Manitoba 2011 Flood Review Task Force. April 2013. "Report to the Minister of Infrastructure and Transport." Retrieved August 26, 2021. (https://www.gov.mb.ca/asset_library/en/2011flood/flood_review_task_force_report.pdf)

24. Boluwade, A. and Rasmussen, P.F. June 2015. Frequency of floods in a changing climate: a case study from the Red River in Manitoba, Canada. Proceedings of the International Association of Hydrological Sciences, 371:83-88. Retrieved on August 26, 2021. (https://www.researchgate.net/publiction/279245493_Frequency_of_floods_in_a_changing_climate_a_case_study_from_the_Red_River_in_Manitoba_Canada)

25. Puxley, Chinta. 2012. "Manitoba First Nations residents sue provincial government over 2011." Canadian Press, April 5. Retrieved August 20, 2021. (https://www.winnipegfreepress.com/breakingnews/manitoba-first-nations-residents-sue-provincial-government-over-2011-flooding-146321725.html)

26. Wherry, Aaron. 2021. "Whatever else happens, this Parliament looks set to be (mostly) about climate change." CBC News, November 23. Retrieved November 23, 2021. (https://www.cbc.ca/news/politics/climate-change-b-c-flooding-trudeau-1.6258852)

27. Moudrak, N., Feltmate, B., Venema, H., Osman, H. 2018. Combating Canada's Rising Flood Costs: Natural infrastructure is an underutilized option. Prepared for Insurance Bureau of Canada. Intact Centre on Climate Adaptation, University of Waterloo. Retrieved August 8, 2021. (http://assets.ibc.ca/Documents/Resources/IBC-Natural-Infrastructure-Report-2018.pdf)

28. D'Souza, Steven, McDonald, Jeremy, and Cowley, Jenny. 2021. "Up to 10% of homes could now be 'uninsurable' because of flood risk. Yours may be one of them." CBC News, November 26. Retrieved November 26, 2021. (https://www.cbc.ca/news/canada/marketplace-home-insurance-1.6262386)

29. Province of Manitoba. No date. "Red River Floodway: Background and Description." Retrieved on September 5, 2021. (https://www.gov.mb.ca/mit/wms/rrf/index.html)

30. Canadian Society for Civil Engineering. No date. "Red River Floodway." Retrieved September 5, 2021. (https://csce.ca/en/historic-site/red-river-floodway/)

31. International Joint Commission. No date. "Role of the IJC." Retrieved on September 15, 2021. (https://www.ijc.org/en/who/role)

32. United Nations Economic and Social Council. February 1, 2021. Population, food security, nutrition and sustainable development: Report of the Secretary-General. Retrieved on July 25, 2021. (https://www.un.org/development/desa/pd/sites/www.un.org.development.desa.pd/files/undesa_pd_2021_e_cn.9_2021_2_advanceunedited.pdf)

33. Advisory Council on Economic Growth. February 6, 2017. Unleashing the Growth of Key Potential Sectors. Government of Canada. Retrieved on July 10, 2021. (https://www.budget.gc.ca/aceg-ccce/pdf/key-sectors-secteurs-cles-eng.pdf)

34. Tollefson, Laurie. 2020. Irrigation Demands in the Prairies and Potential Expansion. Agriculture and Agri-Food Canada. Retrieved on July 10, 2021. (https://gwf.usask.ca/impc/documents/presentations/kick-off-workshop/7_Tollefson_reduced.pdf)

35. Canadian Infrastructure Bank. December 21, 2020. "Historic Expansion of Agriculture Irrigation Infrastructure Reaches Financial Close." Retrieved on August 15, 2021. (https://cib-bic.ca/en/medias/articles/historic-expansion-of-agriculture-irrigation-infrastructure-reaches-financial-close/)

36. Eneas, Bryan. 2020. "Sask. gov't announces $4B project to double irrigable land in province." CBC News, July 2. Retrieved on August 15, 2021. (https://www.cbc.ca/news/canada/saskatchewan/govt-announces-4-billion-project-double-irrigable-land-1.5635076)

37. Saskatchewan Water Security Agency. No date. 25 Year Water Security Plan. Government of Saskatchewan. Retrieved on August 15, 2021. (https://www.wsask.ca/about/publications/25-year-water-security-plan/)

38. Winnipeg Metropolitan Region. June 11, 2021. Draft Plan 20-50: Regional Growth and Servicing Plan. Retrieved on September 4, 2021. (https://20to50.ca/wp-content/uploads/2021/06/Plan20-50_draft.pdf)

39. Province of Manitoba. November 29, 2021. "Province investing in water infrastructure to support needs in Morden and region." Retrieved on November 29, 2021. (https://news.gov.mb.ca/news/index.html?item=52785)

40. Province of Manitoba. November 24, 2021. "Province advancing application for phase 2 of the North End Water Pollution Control Centre and the Winnipeg Transit Master Plan." Retrieved on November 24, 2021. (https://news.gov.mb.ca/news/index.html?item=52768)

41. Al-Adhaileh, Mosleh and Alsaade, Fawaz Waselallah. April 2021. Modelling and prediction of water quality using artificial intelligence. Sustainability, 13(8):4259. Retrieved on July 10, 2021. DOI:10.3390/su13084259.

42. Avishek, Kumar and Syed, Ali Asad Risvi, et. al. July 2018. Using machine learning to assess the risk of and prevent water main breaks. KDD '18: Proceedings of the 24th ACM SIGKDD International Conference on Knowledge Discovery and Data Mining, Pages 472–480. Retrieved on July 10, 2021. https://doi.org/10.1145/3219819.3219835

43. Gordon, Mia. 2021. "How AI may be a game changer in fighting wildfires before they start." The Weather Network, July 27. Retrieved on July 27, 2021. (https://www.msn.com/en-ca/weather/topstories/how-ai-may-be-a-game-changer-in-fighting-wildfires-before-they-start/ar-AAMCyS4)

44. Maclean, Cameron. 2021. "In cities and on the land, Manitoba holds possible answers to the climate crisis." CBC News, August 15. Retrieved on August 15, 2021. (https://www-cbc-ca.cdn.ampproject.org/c/s/www.cbc.ca/amp/1.6141179)

45. Government of the Netherlands. National Delta Programme. Retrieved on August 25, 2021. (https://english.deltaprogramma.nl/)

46. Government of California. California Water Plan. Retrieved on August 25, 2021. (https://water.ca.gov/Programs/California-Water-Plan)

47. Government of California. Water Resource Management Strategies. Retrieved on August 25, 2021. (https://water.ca.gov/Programs/California-Water-Plan/Water-Resource-Management-Strategies)

48. Government of California. Water Resilience Portfolio 2020. Retrieved on August 25, 2021. (https://waterresilience.ca.gov/wp-content/uploads/2020/07/Final_California-Water-Resilience-Portfolio-2020_ADA3_v2_ay11-opt.pdf)

49. Marin, Philippe; Tal, Shimon; Yeres, Joshua; Ringskog, Klas B.. 2017. Water Management in Israel : Key Innovations and Lessons Learned for Water Scarce Countries. World Bank, Washington, DC. Retrieved on September 7, 2021 (https://openknowledge.worldbank.org/handle/10986/28097)