

Calgary



The City of Calgary
**Drought
Resilience
Plan**

Land acknowledgment

The City of Calgary is found where two rivers meet, where Indigenous Peoples have been gathering for thousands of years, sharing knowledge and storytelling, and planning for future generations. The traditional names for this place we know as Calgary are Moh-kins-tsis, Wíchispa Oyade, Otot-kwunee and Guts-ists’i – the confluence of our rivers which have given so much to so many.

Elders teach us the importance of acknowledging the land and offering gratitude for the generosity of the gifts that Mother Earth has shared with us. The Drought Resilience Plan addresses the lands and waters of this place, and with this we offer respect to those who have long lived with and stewarded the land and the water.

We acknowledge the ancestral and traditional territories of the people of the Treaty 7 region in Southern Alberta. This includes the Blackfoot Confederacy, made up of the Siksika, Piikani, Amskaapipiikani and Kainai First Nations; the Îethka Nakoda Wícastabi First Nations, comprised of the Chiniki, Bearspaw, and Goodstoney First Nations; and the Tsuut’ina First Nation. The city of Calgary is also homeland to the historic Northwest Métis and to Métis Nation of Alberta, Region 3. We acknowledge all Indigenous peoples who have made Calgary their home.

Together, their relationships to land and waters create rich lessons for which we have a responsibility to listen and learn. We are thankful for the opportunity that this sacred place provides us to engage in reconciliation as we advance drought resilience efforts for our community at large.

“At the confluence of two rivers, the lifeblood of our city, our cultures converged and our story began.”

— Mayor’s Proclamation of Reconciliation (2014)

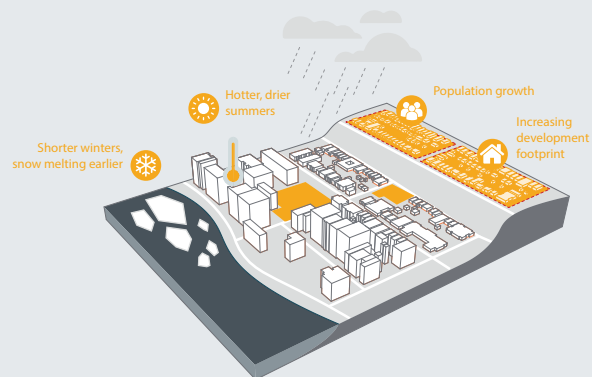
Calgary's commitment to drought resilience

Being *drought-resilient* means that people, ecosystems and businesses are prepared to withstand and recover from the impacts of prolonged periods of dry conditions and water shortages. In the face of increasing drought risk due to climate change, The City of Calgary is committed to creating a drought-resilient city for all Calgarians.

Executive Summary

Calgary is a drought city

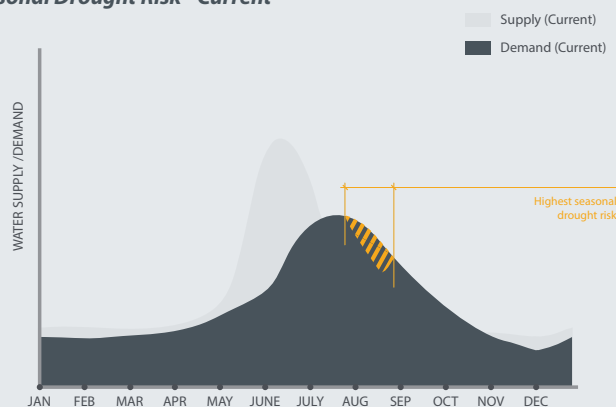
Calgary is located in an arid region of southern Alberta and depends on its river systems for access to water. Because these river systems experience variations in flow rate over the seasons and years, Calgary is vulnerable to seasonal dryness and multi-year drought. At least five major droughts have occurred in the Calgary region in the last century.



Droughts impact more than just the municipal water supply. They have wide-ranging ecological, economic and social consequences. These impacts can be difficult to trace because droughts can emerge gradually.

In Calgary, drought is defined as the condition when the water required for municipal supply, irrigation, and minimum environmental flows diminishes below City of Calgary drought triggers and supporting indicators. The City experiences peak precipitation in the early spring but has the most significant demands on its water supply in the summer. Drought risk is highest in this period where supply is low and demand is high.

Seasonal Drought Risk - Current



Calgary's commitment to drought resilience

The City of Calgary has made a commitment to drought resilience. Drought resilience means that people, ecosystems, and businesses are prepared to withstand and recover from the impacts of prolonged periods of dry conditions and water shortages.

In the face of increasing drought risk due to climate change, The City is committed to working toward a drought-resilient city for all Calgarians.

This is a shared commitment—drought resilience requires coordinated action from citizens, industry, and government, and purposeful relationships with neighbours and licence holders in the Bow River Basin. The City's commitment is captured in this Drought Resilience Plan. The Drought Resilience Plan is aligned with policy at the provincial, regional and municipal levels.

The Drought Resilience Plan builds on many years of work that have positioned Calgary well to become drought-resilient. Highlights from The City's journey include:

- 1980s to 90s** – Calgary initiates distribution leak detection and main replacement program, water meter incentive program and water conservation and education programs.
- 2002** – Mandatory water metering implemented through the Water Utility Bylaw.
- 2005** – City Council approves the Water Efficiency Plan.
- 2006** – The South Saskatchewan River Basin is closed to new water licences.
- 2016** – Calgary initiates seasonal drought response operations.
- 2020** – City Council approves the Water Security Framework: One Calgary, One Water.
- 2021** – Culmination of a two-year strategic planning process captured in the Drought Vulnerabilities, Risks and Mitigation Strategies report.
- 2022** – Engagement with the public and interested parties on drought plan completed.
- 2023** – Drought Resilience Plan is finalized.

Vulnerability and risk

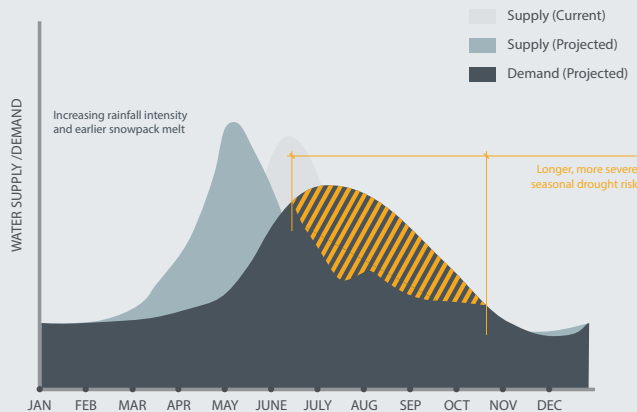
Calgary's current vulnerabilities were assessed in the 2021 Drought Vulnerabilities, Risks, and Mitigation Strategies report. The report highlighted the following areas of drought vulnerability in Calgary:

- + Environmental needs and in-stream flows
- + Stormwater quality degradation and vulnerabilities of green stormwater infrastructure during drought

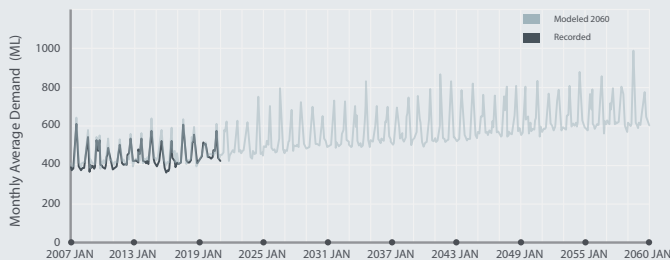
- + Water supply availability and source water quality for municipal uses (particularly on the smaller Elbow River)
- + Wastewater impacts to river quality
- + Impacts to utility revenues during drought

These vulnerabilities will be compounded as Calgary sees increased drought risk due to climate change. Heavier, earlier rainfall in the spring and hotter, drier summers mean that Calgary's seasonal drought risk is extended and deepened. This elevated risk is compounded by increased demand from projected urban growth and limitations on water licensing.

Seasonal Drought Risk – Projected



Calgary's Projected Water Demand



Framework for a drought-resilient Calgary

This plan sets out a Framework for a Drought-resilient Calgary. The framework is comprised of goals and strategic actions that will move Calgary toward drought-resilience in the short, medium and long-term.

Goals

- Reduced water demand
- Protected water supply
- Drought preparedness
- Healthy landscapes
- Strong relationships

These goals are premised on guiding principles of climate resilience, water stewardship, equity & inclusion and innovation.

Strategic Actions

For each goal, this plan presents three strategic actions.

Reduced Water Demand

-  A1 – Update the 2005 Water Efficiency Plan
-  A2 – Understand the financial impact of drought on City operations and customers
-  A3 – Evaluate water restrictions as a tool to support drought resilience and operations

Protected Water Supply

-  B1 – Leverage water management legislation and policy
-  B2 – Evaluate and implement alternate water supply sources
-  B3 – Identify and advocate for new water storage options

Drought Preparedness

-  C1 – Monitor for drought
-  C2 – Ensure The City, businesses and Calgarians are ready for drought
-  C3 – Model long term climate impacts to water supply

Healthy Landscapes

-  D1 – Protect the aquatic environment in low flow and drought conditions
-  D2 – Preserve and restore natural landscapes
-  D3 – Integrate drought considerations into the built form

Strong Relationships

-  E1 – Collaborate with water users in the Bow River Basin
-  E2 – Build ongoing dialogue with Indigenous groups for drought resilience
-  E3 – Reduce Calgarians' vulnerability to drought

These strategic actions will be built out into more detailed workplans through implementation.

Conclusions

All Calgarians have a role to play in building a more drought-resilient city. Fortunately, if holistically implemented, the Drought Resilience Plan will provide a framework for building resilience. Its actions and initiatives will make Calgary more adaptable in the face of drought—helping the city better withstand, endure and recover from extended periods of dry weather.





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1 Calgary is a drought city

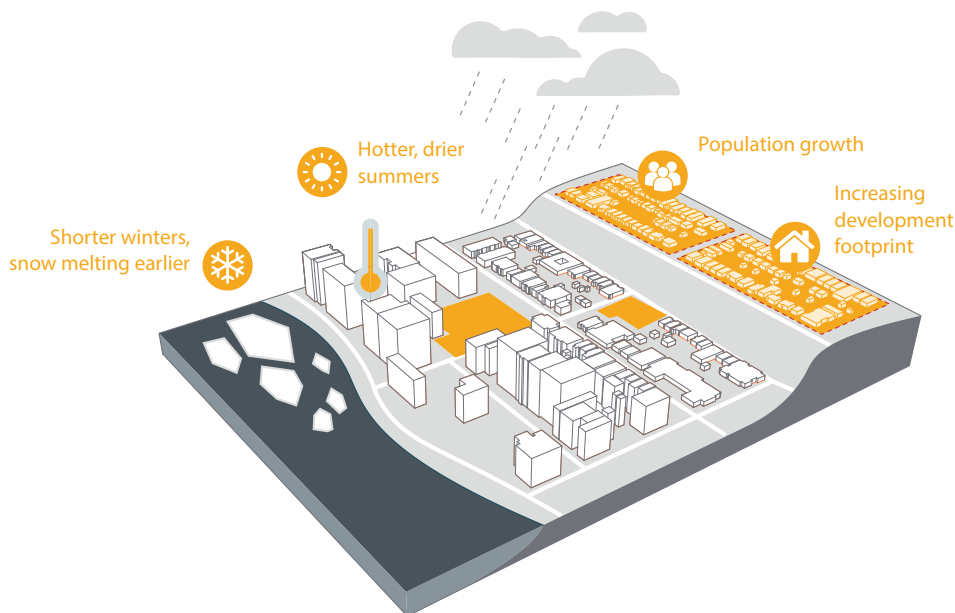
1.1 Introduction

Water is a source of life. It has driven patterns of settlement throughout human history and continues to be a requisite for survival, as it supports the health of people, ecosystems and industry. Calgary is located in an arid region of southern Alberta and depends on its river systems for access to water. Because these river systems experience variations in flow rate over the seasons and years, Calgary is vulnerable to changes in the availability of water. Prolonged periods of dry weather can lead to a condition where human and natural systems do not have sufficient water to thrive. This is called drought.

Drought has received renewed attention over the last decade, as climate change and urban growth reshape supply and demand in the Bow River watershed. Climate change is projected to heighten

overall drought risk in Calgary, intensifying the variability and uncertainty of spring river flows, raising summer temperatures and resulting in less water in the rivers and reservoirs as water demands from municipal and agricultural users are anticipated to increase significantly. These changes will require enduring adaptations in both natural and human systems. Calgary's continued growth adds additional drought-resilience challenges, as a finite quantity of water must be managed across more users.

Drought pressures



The Drought Resilience Plan

This **Drought Resilience Plan** provides a framework for building resilience to drought in Calgary. It describes actions and initiatives that will ensure Calgary is more adaptable in the face of drought—helping the city better withstand, endure, and recover from extended periods of dry weather. The Drought Resilience Plan has four key objectives:

1. Strengthen Calgary's resilience to drought through proactive planning and response.
2. Affirm The City's commitment to ecosystem health and watershed stewardship during drought planning and response.
3. Raise local awareness about the impacts of drought and Calgary's identity as a drought city.
4. Maintain confidence in The City's ability to manage drought with citizens, businesses and communities.

A 2021 survey found that Calgarians have a low understanding of the risks and potential impacts of drought (Probe Research, 2021). The same survey also showed that Calgarians are concerned about the impacts of climate change and want to ensure that the city's water supply is reliable (Probe Research, 2021). The Drought Resilience Plan will help link these interconnected ideas, building a stronger understanding of Calgary's drought risks to reshape how we value water leading up to and during drought.

The Drought Resilience Plan is organized into three chapters and supporting appendices.

Chapters

Chapter 1 - Defines drought, outlines its impacts and describes drought-resilience and its alignment with other City of Calgary policies.

Chapter 2 - Delves into Calgary's experience of drought—its history of drought action, its current vulnerabilities and the trends that will shape drought in the coming decades.

Chapter 3 - Presents the Drought Resilience Framework and outlines next steps through a series of priority strategic actions.

The drought disconnect

80 per cent of Calgarians agree that a reliable water supply is essential to their quality of life. However, less than 50 per cent are concerned about droughts occurring within the next five years and only 20 per cent believe that a drought can last for multiple years (Probe Research, 2021).

Drought and water security

The City of Calgary defines water security as having enough water for human well-being, ecosystem resilience and economic activity now and for future generations. The One Calgary One Water framework for Calgary's water-secure future outlines The City's top risks to water security (climate change, population growth and water license limits), key initiatives underway and priority actions to address questions of future water security (The City of Calgary, 2019). The City manages water security by having the right balance of activities across the connected levers of water supply, water demand and systems operations. Creation of the Drought Resilience Plan is a key action identified in this strategy.



1.2 Defining drought

Types of droughts

Drought refers to a prolonged period of dry conditions that causes shortages in the availability of water. This can include shortages of precipitation, stream flow or ground water. Droughts can last anywhere from a few weeks to many years. Unlike other more time-bound and geographically discrete hazards such as floods, droughts are a “creeping” phenomenon. The slow onset of a drought sometimes makes it difficult to tell when a drought period is beginning or ending—or how long it will last (American Planning Association, 2019).

Drought is also a relative condition, meaning its definition can differ depending on location, time of year or impacted area. There are five commonly used drought classifications, based on their area of impact. These drought types may occur independently or simultaneously:

- + **Meteorological drought:** less precipitation over a prolonged period.
- + **Agricultural drought:** insufficient soil moisture to meet the needs of crops.

- + **Hydrological drought:** lake, river, reservoir or groundwater supplies are below average levels due to a lack of precipitation.
- + **Ecological drought:** prolonged and widespread deficit in naturally available water supplies that creates multiple stresses across ecosystems.
- + **Socioeconomic drought:** people and the economy are impacted due to a prolonged absence of water in a region.

The conventional municipal understanding of drought is focused on the relationship between municipal water supply and demand. From this perspective, the severity of a drought is measured by the margin of water available to meet demand. In Calgary, commitments to the natural environment and relationships with other major license holders require a broader definition for drought:

In Calgary, drought occurs when the water required for municipal supply, irrigation and minimum environmental flows diminishes below City of Calgary drought triggers and supporting indicators.

Picturing drought

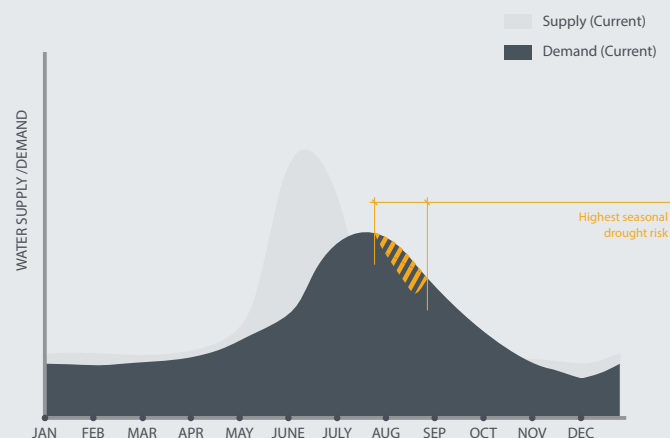
The following graph highlights Calgary’s risk of seasonal drought by comparing the area’s precipitation and water demand trends throughout the year. Calgary’s precipitation typically arrives in a sharp spring spike, recharging groundwater, refilling reservoirs and creating peaks in surface flows.

This burst of water has a sharp fall-off as the region’s warm, dry summer sets in. Water demand follows a different curve. Calgarians place the highest demands on the water supply throughout the summer months.

Led by outdoor water use, summers in Calgary typically see a 20-40 per cent increase in water demand compared to the annual average. This summer period—when demand is high and supply is low—is when Calgary becomes particularly susceptible to seasonal drought. It is also when the effects of multi-year drought are most acute.

This graph is a useful tool to help understand the *when* and *why* of Calgary’s drought risk.

Seasonal Water Supply and Demand



Flood and drought

The most acute reminder of the variability of Calgary's water system arrives each spring, as seasonal precipitation threatens the city with flooding. As water levels rise, it is tempting to believe drought as a problem that is the opposite of flooding. After all, how could there be too much water and not enough at the same time? Unfortunately, Calgary's sudden spike in spring precipitation is followed by a decrease in flow through the summer. While Calgary's demand for water stretches throughout the summer, it is only in the late winter and early spring that the city receives high levels of precipitation. In the winter, precipitation falls as snow-pack across the watershed. This acts like a water reservoir in the mountains which is released in the spring and early summer when temperatures increase and precipitation turns to rainfall. Because of this, both high flows and drought can be experienced in the same year. In fact, high flows can occur throughout a multi-year drought. In some cases, drought can even make flood risk worse. Drought reduces the health and quantity of vegetation, which plays an important role in slowing and filtering precipitation on its way to the river systems. This faster runoff rate due to reduced vegetation can intensify both flooding and bank erosion. Climate change will increasingly exacerbate these two extremes, causing increased shifts in when and how water is received from the watershed.

For more information about flooding in Calgary, view Calgary's Flood Resilience Plan at calgary.ca/floodinfo.



Multi-year drought

Drought can occur over various time scales—from weeks to years. When a community experiences dry conditions over multiple years, the impacts may intensify and cascade into long-term economic, environmental and societal impacts across the watershed. A multi-year drought is among Calgary's top climate hazards and the risk is magnified by population growth and high water consumption (City of Calgary, 2019). Increased summer temperatures and decreased summer precipitation indicate that meteorological drought conditions may become more common, prolonged and widespread. Drought impacts may also accumulate in severity when combined with other compounding climate hazards such as heatwaves, wildfires and seasonal changes (The City of Calgary Climate Projections Report, 2022a).



Drought in different languages

Throughout The City's engagement with Calgarians from different cultures and language backgrounds, it was clear that these participants understood the concept and condition of drought, but the word "drought" itself carried less meaning. Many cultures and languages have words to describe the condition of drought, whether it is in the context of a place that is always dry or in the context of a place that has a distinct dry season.



How important are glaciers to Calgary's water supply?

Glacial melt is important. On average, glacier melt makes up approximately three per cent of Calgary's annual river runoff. Most of The City's water supply comes from precipitation - both snow-melt and rain.

However, if Calgary were to experience a drought extending into August when precipitation is at its lowest, glacial melt would contribute eight to 20 per cent of the city's water supply.

With rising temperatures due to climate change, glaciers will continue to shrink, reducing our steady supply of glacial melt in Calgary's rivers to sustain the city over the driest months of the year.



1.3 The impacts of drought

The impacts and consequences of drought are broad and far-reaching. Some impacts are more obvious, like reduced water for drinking and irrigation. Others are harder to see but still leave profound and lasting effects. The following list of impacts highlights the breadth of issues caused by drought—and the ways drought can increase the risk of other hazards, including floods, heatwaves and wildfires.

Water supply impacts

Drought reduces the water available to provide for Calgary's core infrastructure: clean water for drinking, firefighting, irrigation and industry. Drought can lead to:

- + Impacts to water treatment & supply
- + Restrictions on water use
- + Reduced quality of green space in urban areas
- + Interruptions to community services

Ecological impacts

Drought reduces the water available to natural spaces and ecosystems to thrive. This can mean:

- + Loss of habitat and biodiversity
- + Increased susceptibility to disease, pests and invasive species
- + Reduced water quality
- + Stress to fish and wildlife
- + Increased incidence and severity of wildfires
- + Increased severity of flooding

Economic impacts

Drought reduces the water available for irrigation, industry and recreation. These issues are compounded by the unpredictability and instability of multi-year drought conditions:

- + Interruptions to business
- + Impacts on farmers and food prices
- + Loss in recreation and tourism
- + Increased cost of municipal services
- + Impacts to large-scale commercial and industrial water users

Social impacts

Drought has a direct impact on the physical and mental health of citizens. As a regional phenomenon, coordination across jurisdictions adds another layer of complexity.

Social impacts include:

- + Mental and physical stress
- + Air quality impacts from increased dust and pollutants
- + Reduction/modification of recreation opportunities
- + Reduced quality of important cultural landscapes
- + Impacts to food security
- + Unequal distribution of impacts between users

Although the impacts of drought can be profound and lasting for any community, The City of Calgary has a responsibility to anticipate and moderate the negative impacts of drought by better understanding localized drought impacts and vulnerabilities. The City's drought risk and vulnerability assessment is further elaborated in Section 2.3.

Knowing how drought will impact our community and region will allow The City to build plans and strategies around mitigating these impacts and building resilience to drought. This will support a healthier future for people, ecosystems and industries.





A shared commitment

The creation and implementation of the Drought Resilience Plan has, and will continue to, rely on the support of City business units and citizens, as well as communities and partners across the larger Bow River Watershed, who have shared their guidance, expertise, and support. These include:

- + Western Irrigation District, Bow River Irrigation District, Eastern Irrigation District.
- + Government of Alberta
- + Calgary Metropolitan Region Board and Member Municipalities
- + Alberta Water Council
- + Bow River Basin Council and Watershed Stewardship Groups in the Basin
- + Landscape and industry associations
- + Academic partners
- + Indigenous community representatives (see Goal E2)

1.4 A commitment to drought resilience

Calgary is a drought city, and droughts bring a wide range of complex and costly impacts. In this context, The City has both an obligation and a powerful incentive to reduce the harm caused by future droughts. This sets the stage for The City's commitment to drought-resilience:

This commitment is the foundation of the Drought Resilience Plan. It is bolstered by sound technical knowledge, proven best practices and robust public input. To make good on this commitment, The City has developed a solid understanding of future drought risks, identified key vulnerabilities, and advanced drought preparedness and response measures.

Residents, businesses and interested parties will all continue to provide input as Calgary takes action to become drought-resilient.

Drought resilience means that people, ecosystems and businesses are prepared to withstand and recover from the impacts of prolonged periods of dry conditions and water shortages. In the face of increasing drought risk due to climate change. The City of Calgary is committed to becoming a drought-resilient city for all Calgarians.



1.5 Building resilience through a collaborative and comprehensive approach

The City of Calgary's focus on understanding future drought risks and vulnerabilities, and advancing drought preparedness and response measures requires a collaborative and comprehensive framework built on a foundation of scientific, technical and public input. This approach encourages Calgarians to feel ownership of and responsibility towards the recommendations in the Drought Resilience Plan, which is key for a successful implementation.

From a scientific and technical perspective, The City leveraged many internal subject matter experts who work directly with water resources and natural asset management. This initial consultation helped to provide a fundamental scientific and technical understanding of the current opportunities and constraints faced by The City when addressing drought-resiliency. Additionally, The City engaged with water resource management partners throughout Calgary. Through this approach, The City was able to benchmark performance and identify best practices from other leading drought-prone municipalities across Canada, North America and the world.

The City also listened to residents, businesses and interested parties about what matters to them most and ways they can support Calgary's continued evolution as a drought-resilient city.

Emphasis was placed on seeking feedback from equity-deserving Calgarians through partnerships with equity-based community organizations. In public engagement, The City presented proposed strategies and frameworks to foster dialogue and discussion. The result of this dialogue is the framework presented below. The Drought Resilience Plan integrates new ideas and knowledge sources to ensure it reflects community needs and values as well as strengthens The City's resilience pathway forward.

Also of significance is the input of Indigenous Peoples and traditional knowledge keepers who will help us build on and strengthen a Drought Resilience Plan that reflects The City's commitment to honouring the lands in the traditional territories of the Treaty 7 Nations, Métis Nation of Alberta Region 3 and urban Indigenous Calgarians. As described in section 3.7.2 of this report, The City of Calgary remains committed to seeking opportunities for ongoing dialogue with First Nations, Métis and Urban Indigenous groups leading up to, and during times of drought.



1.6 The Drought Resilience Plan – alignment and coordination

The Drought Resilience Plan draws links to other provincial, regional and City priorities and initiatives, contributing to broader goals and directing further action.

Provincial alignment

The *Provincial Water For Life Strategy* includes goals for a safe and secure drinking water supply, healthy aquatic ecosystems and reliable quality water supplies for a sustainable economy. Attaining these goals depends, in part, upon Albertans sharing a new perspective that water is a scarce resource. This is equally true for the success of the Drought Resilience Plan.

The *Alberta Water Act* governs the allocation of water from natural watercourses. This includes management of water licence priorities and other actions regarding Water Act provisions during water shortages.

Regional alignment

The *South Saskatchewan Regional Plan* identifies strategic directions for the region, including for growth, communities and the environment. It directs strategies for an efficient and resilient water supply, including supporting drought management planning and preparedness. The City of Calgary must also consider drought impacts on our existing servicing commitments to regional customers.

Coordination with the *Calgary Metropolitan Regional Board (CMRB)* on matters related to drought-resilience is critical to ensure objectives for Water Stewardship in the Growth Plan (CMRB, 2022) are achieved. The City of Calgary must also consider drought impacts on our existing servicing commitments to regional customers.

Municipal alignment

The Drought Resilience Plan is key to realizing *Calgary's Municipal Development Plan (MDP)* goal of 'Greening the City,' and addresses many high-level policies about water, climate change, land and natural infrastructure. Drought-resilience is a foundational characteristic of a climate-resilient city, and the Drought Resilience Plan responds directly to Council's declaration of a climate emergency. The Plan is also an action in *Calgary's Climate Strategy - Pathways to 2050 and Adaptation Plan* and is a key pillar of the *One Calgary One Water Security Framework*. Other areas of corporate

alignment include the *Resilient Calgary Plan*, the *Source Water Protection Plan*, the *Stormwater Strategy*, *Riparian Action Program*, *Flood Resilience Plan*, *Open Space Plan* and *Water Management Strategic Plan*.

Having enforceable water restriction policies integrated into the municipal bylaws is an integral part of an effective drought plan. To manage water use in times of shortage, Calgary's Water Utility Bylaw 40M2006 outlines a multi-staged plan for mandatory water restrictions based on the severity of water shortage (The City of Calgary, 2006).



2 Vulnerability and risk

2.1 Calgary's history of drought

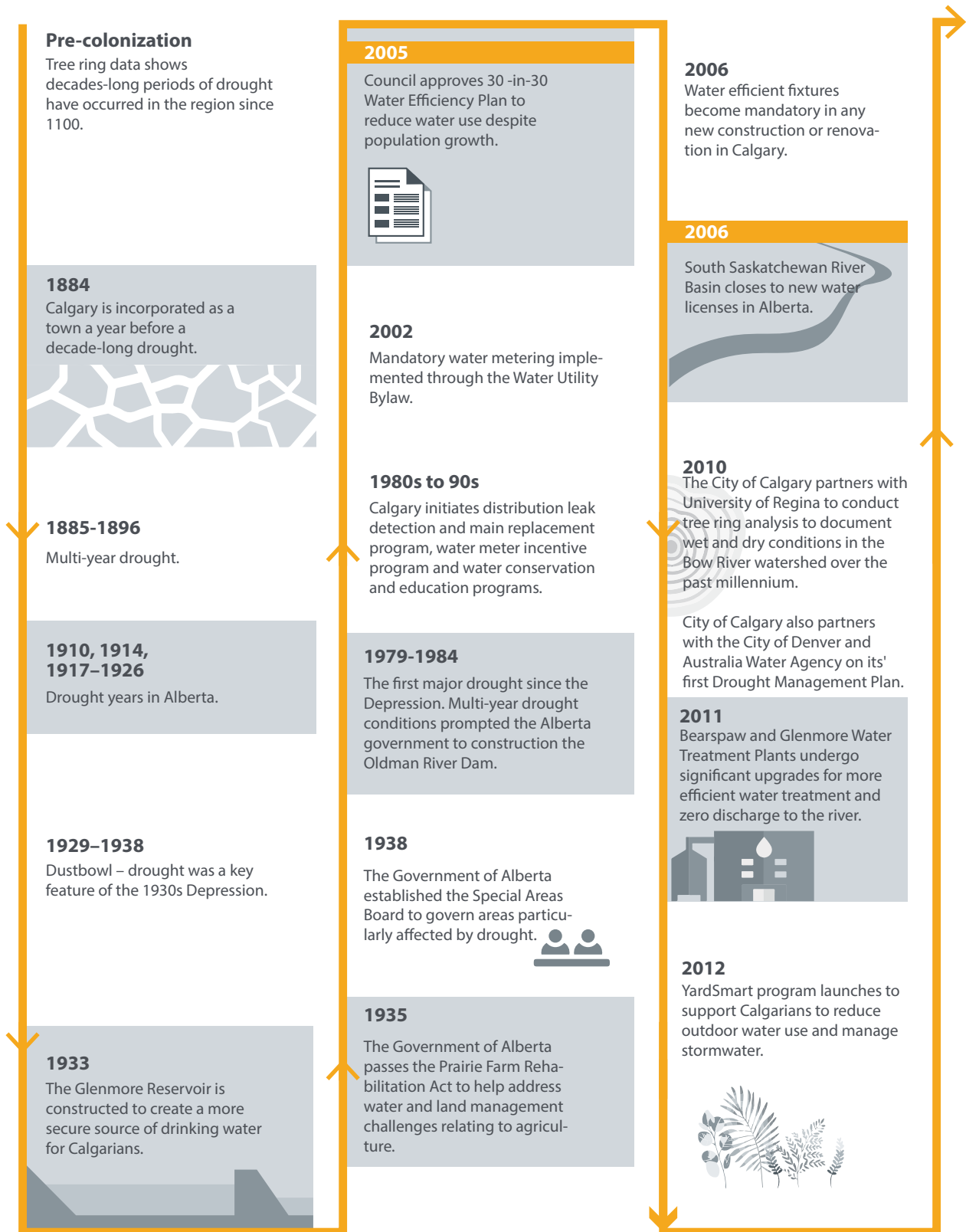
Drought is an integral part of Calgary's history—the area entered a decade-long drought just one year after Calgary was incorporated as a town. Indeed, the landscape of southern Alberta has gone through cycles of drought for thousands of years. In the last 200 years alone, the Canadian prairies have been affected by drought at least 40 times (Sauchyn et al, 2012). The following timeline highlights key milestones in Calgary's drought journey.

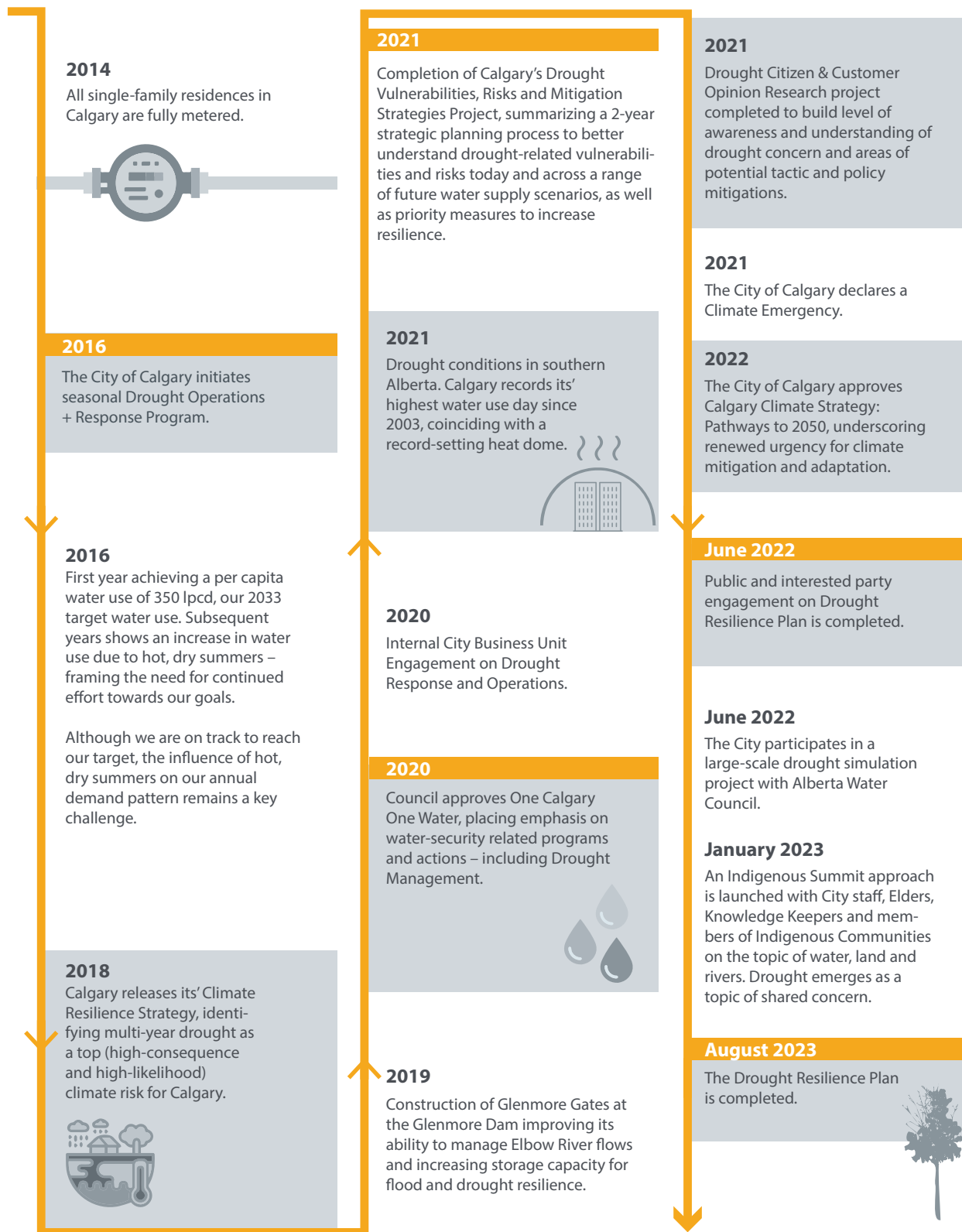
A plan decades in the making

Planning and preparing for a drought-resilient city and region are driven by calls to action in Calgary's Climate Strategy and is a fundamental component of The City's Water Security Framework. Importantly, this plan builds on decades of proactive planning and major milestones around water efficiency and water security.



2.2 Timeline





2.3 Current vulnerabilities

In 2022, The City of Calgary completed a Drought Vulnerability and Risk Assessment to understand the potential impacts of drought on our community. The assessment was the result of a two-year strategic planning process. The project used a scenario-based approach to present a range of plausible futures to assess vulnerabilities and risks of seven systems: water supply, wastewater, stormwater, operational support, environmental, organizational and community and watershed (Jacobs, 2022).

Understanding the systems that are most vulnerable to drought is an important step in order to identify adaptation and mitigation strategies for resilience building. The diagram on the right groups the outcomes of the risk and vulnerability assessment into four key themes: environment and ecosystems, water supply, financial and watershed community. Additional context is provided below for the systems identified as having the highest vulnerabilities to drought, and how those vulnerabilities would impact our community.

Environmental water demands and in-stream flows

The report identified in-stream flows (meaning, the quantity, timing and quality of water flow required to sustain freshwater ecosystems) as one of the systems with the highest vulnerability. Flows, water quality and the potential for reduced biodiversity and influx of invasive species were the most vulnerable components.

Stormwater

Uncertainty about vegetation adaptability during longer drought periods and the potential for water quality degradation resulting in wetlands and other green stormwater infrastructure being vulnerable to drought.

Water supply

Limited reservoir storage reduces The City's ability to adapt to changes in timing and quantity of flows in both the Bow and Elbow watersheds. Source water quality is also vulnerable, especially with the increasing risk of wildfire during drought conditions.

Wastewater

Reduced in-stream flows could impact wastewater discharges. Requirements related to water quality during low flow to support aquatic habitat could result in the need for more advanced treatment processes.

Elbow River

The Elbow River system is slightly more vulnerable to the effects of climate change and drought due to its small watershed and potential changes in flow.

Revenue-based funding

Revenue-based funding for water and wastewater utilities is vulnerable to droughts that may occur in multiple consecutive years because of water restrictions leading to lower revenues and higher operational and staffing costs during drought.

Dams and reservoirs

Across Calgary's watershed, TransAlta, The City of Calgary, Alberta Environment and Parks and Irrigation District dams and reservoirs are managed with both flood and drought in mind. Reservoirs are lowered in the spring to mitigate flooding and then filled for water supply throughout the summer. It is a delicate balance and an opportunity to plan for integrated climate risks in a coordinated fashion. Water storage capacity will be an increasing priority in response to both flood and drought impacts.

- Risks to environmental flows and regulatory requirements for water quality.
- Short term loss of environmental function and services.

- Increased trade-offs between human and environmental needs.

- Water quality concerns in rivers, creeks, wetlands and stormponds.

- Impacts to urban forests, park facilities, natural infrastructure and landscapes due to reduced precipitation and reduced irrigation.



Environment & Ecosystems



Water Supply

- Multi-year droughts and resulting water supply deficits.

- Water quality and treatment challenges from wildfires upstream of Calgary.

- Disruption to customer water use.

- Limits to current water licences and capacities.



Financial

- Financial instability during seasonal and multi-year drought conditions.

- Disruption to agricultural industry.



Watershed Community

- Governance, resourcing and coordination challenges during drought response.

- Impacts to local and regional tourism and recreation industry.

Drought Vulnerabilities

2.4 The future of drought risk in Calgary

Climate change

Climate change brings many water-related hazards, including floods, droughts and declining water quality. These hazards are interdependent and threaten people, infrastructure, and the environment. An integrated approach to water management is essential to ensure a reliable, secure and high-quality water supply for Calgarians and downstream users.

This City’s Climate Strategy recognizes drought as one of Calgary’s eight main climate hazards. Projections indicate that regional warming is expected to continue at an accelerated rate. As a result, Calgary’s seasons are starting to shift. Winters are becoming shorter with spring arriving earlier. Meanwhile, summers are becoming longer with fall arriving later. Drought and water shortages are likely to increase in regularity.

Short duration, high-intensity precipitation is likely to increase as the amount of water vapour carried in the air rises with higher temperatures. Precipitation type and timing will also start to shift as the city receives less snow and more rain in the fall and spring months, resulting in more damaging storms and a smaller

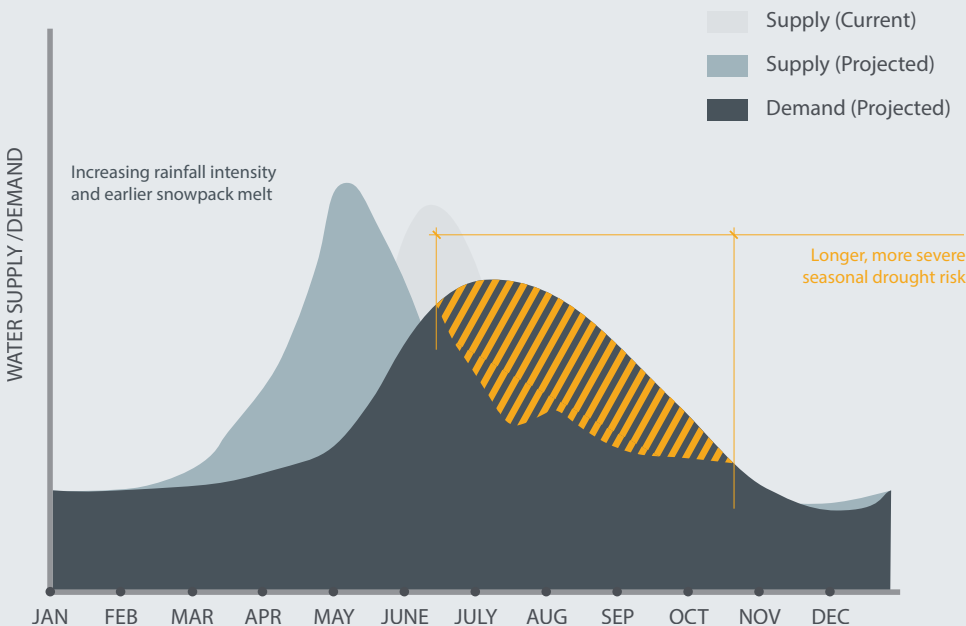
“Water management systems in snow-dominated regions are based on the predictability of snow-pack and runoff, and much of that predictability could go away with climate change.”

- Will Wieder, National Centre for Atmospheric Research, (Water Canada, 2022)

mountain snow-pack and glacial runoff. An earlier snow-melt will lead to decreased summer stream-flow, while short duration high intensity storms cause rainfall that is difficult to capture and utilize in the long term.

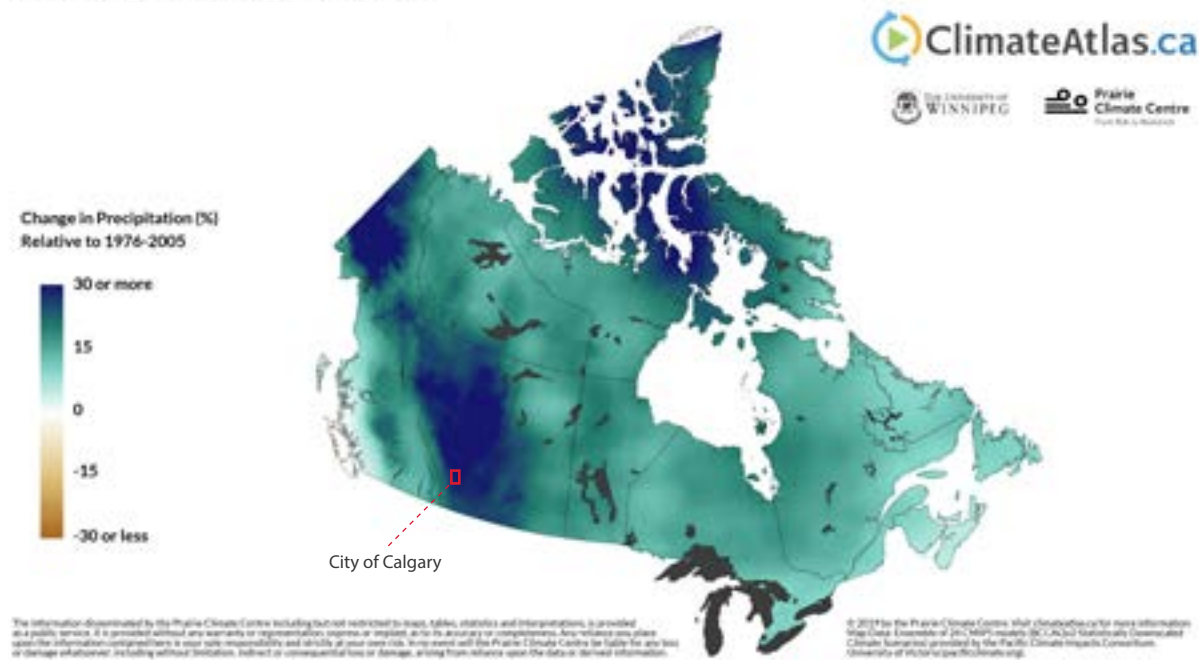
The following maps project 25 to 45 per cent increases in April precipitation when rivers are already full and 10 to 20 per cent decreases in August precipitation when precipitation is most needed for the Calgary area. Together, these trends show a growing vulnerability to drought.

Projected seasonal water supply and demand



2051-2080 Projected change in total precipitation: April

(Prairie Climate Centre, 2023)

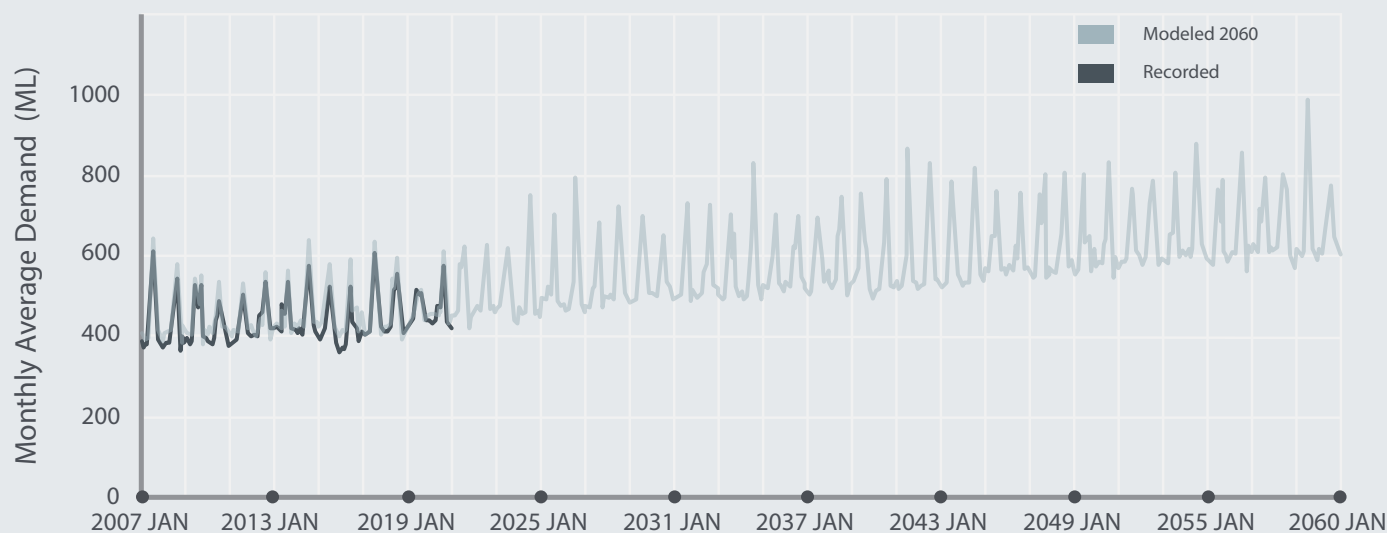


2051-2080 Projected change in total precipitation: August

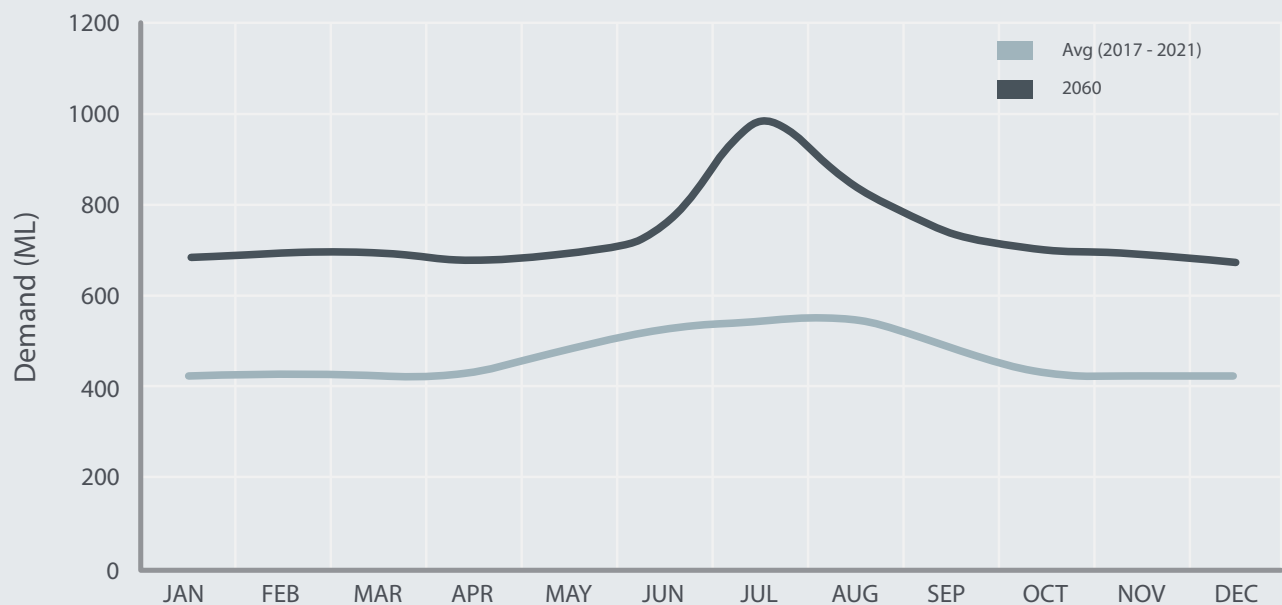
(Prairie Climate Centre, 2023)



Calgary water demand forecast



Calgary projected average monthly demand



Growth

A drought-resilient city and region embeds consideration of drought and water security into growth and land use planning. Drought and water security can be limiting factors for growth, as population growth will exert increased pressure on limited water resources.

The Calgary metropolitan region is projected to add about one million people between 2018 and 2048 to 2053, with the city of Calgary anticipated to attract the largest number of new residents (CMRB, 2022). However, as the region grows, a greater percentage of the population are likely to be located outside of the city of Calgary's boundaries. Continued growth and investments in new industries and the overall economic resilience of the Calgary region will rely on investment in climate and drought-resilience and a secure supply of water. These are the foundations of Council's Strategic Directions (The City of Calgary, 2022c).

This highlights the importance of building on Calgary's current efforts to improve water efficiency—improving the infrastructure, capacity and practices that will enable the city to thrive as it grows. It also underscores the importance of a shared responsibility for water management and opportunities to advance regional collaboration for water security.

Water licensing

In the South Saskatchewan River Basin (SSRB) where Calgary is located, water resources are allocated according to Alberta's Water Act, which provides licences to users to meet their water needs. Notably, the South Saskatchewan is closed to any new surface water allocations—an indication of the immense pressure on the existing water system. This pressure will be intensified with a changing climate altering long-term water supply.

When a water shortage occurs, the Water Act also has provisions to allow water users to assert their priority to water and/or share water via an assignment agreement or water transfer (Government of Alberta, n.d.). Asserting water license priority may be necessary during extreme drought and would be nuanced in terms of water use and licence conditions. Water sharing opportunities were used instead by Irrigation Districts to manage water shortages in Southern Alberta during the 2001 drought (Alberta Water Council, 2021).

Learning from Australia's Millennium Drought

The Millennium Drought, which began in the late 1990s and lasted until 2010, is considered the worst drought in Australia since European settlement. The Public Policy Institute of California examined Australia's response to their historic drought, and identified the following four policy priorities (Hanak et al., 2015):

1. Manage water tightly with better information

Invest in water tracking to enable allocation and delivery with fairness and transparency.

2. Set clear priorities and objectives

Clearly identify priorities for public health and safety to create testable protocols for drought response.

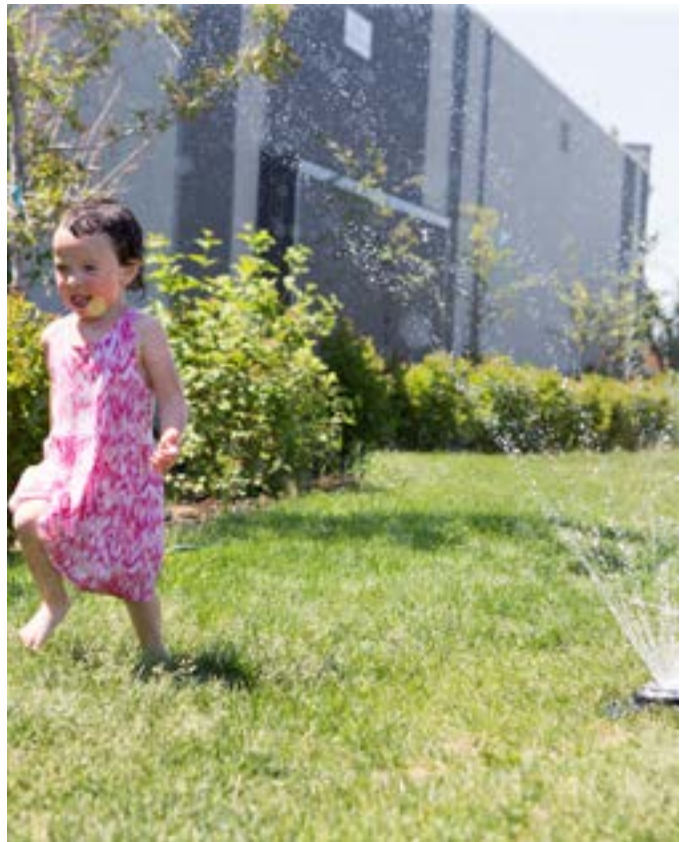
3. Promote demand management and robust supplies

Reduce landscape irrigation, improve conservation-oriented pricing, prevent waste, diversify water sources and manage groundwater.

4. Modernize environmental drought management

Develop an environmental drought plan to prioritize investments that increase natural resilience and set clear actions and protocols.

The City of Calgary holds relatively large and senior licences compared to other municipalities but has lower priority than several other major users in the basin. Calgary's water use is also largely non-consumptive with most water being returned to the river as treated effluent from our wastewater treatment plants. It will be important to continue to work collaboratively with AEP, TransAlta, Western, Bow River and Eastern Irrigation Districts to effectively manage water operations during low flow periods on the Bow River.



3 Drought-resilient Calgary

3.1 Vision for a drought-resilient city

The Drought Resilience Plan envisions a future where Calgary's people, ecosystems and businesses are prepared to withstand and recover from drought and adapt to the increasingly dry conditions the city is likely to experience. A drought-resilient city is one in which its institutions, communities, businesses and individuals can survive, adapt and grow in response to drought.

To achieve this vision, the Drought Resilience Plan presents the road map through which The City will work towards achieving this vision as a drought-resilient city.

This chapter identifies five focus areas, or goals, where The City can have the most impact in achieving this vision. These are:

- a) Reducing water demand
- b) Protecting water supply
- c) Preparing for drought
- d) Protecting, preserving and creating healthy landscapes
- e) Building strong relationships

Each goal includes several priority actions. Collectively, these goals and actions will have an amplifying effect beyond their individual impacts, resulting in a comprehensive and consistent approach to drought-resiliency throughout Calgary and the Bow River watershed.

VISION

As a drought-resilient city, Calgary's people, ecosystems and businesses are prepared to withstand, recover from and adapt to the impacts of drought.



3.2 Drought resilience framework

The Drought Resilience Framework is a purposeful structure that organizes The City's actions to ensure it stays focused on the vision. With the Vision for a drought-resilient city at the heart of the Drought Resilience Plan, five goals are outlined with resulting

priority actions for each. Collectively, all priority actions work in tandem to achieve their individual goals and the overall vision of the Drought Resilience Plan.

Climate equity & drought resilience

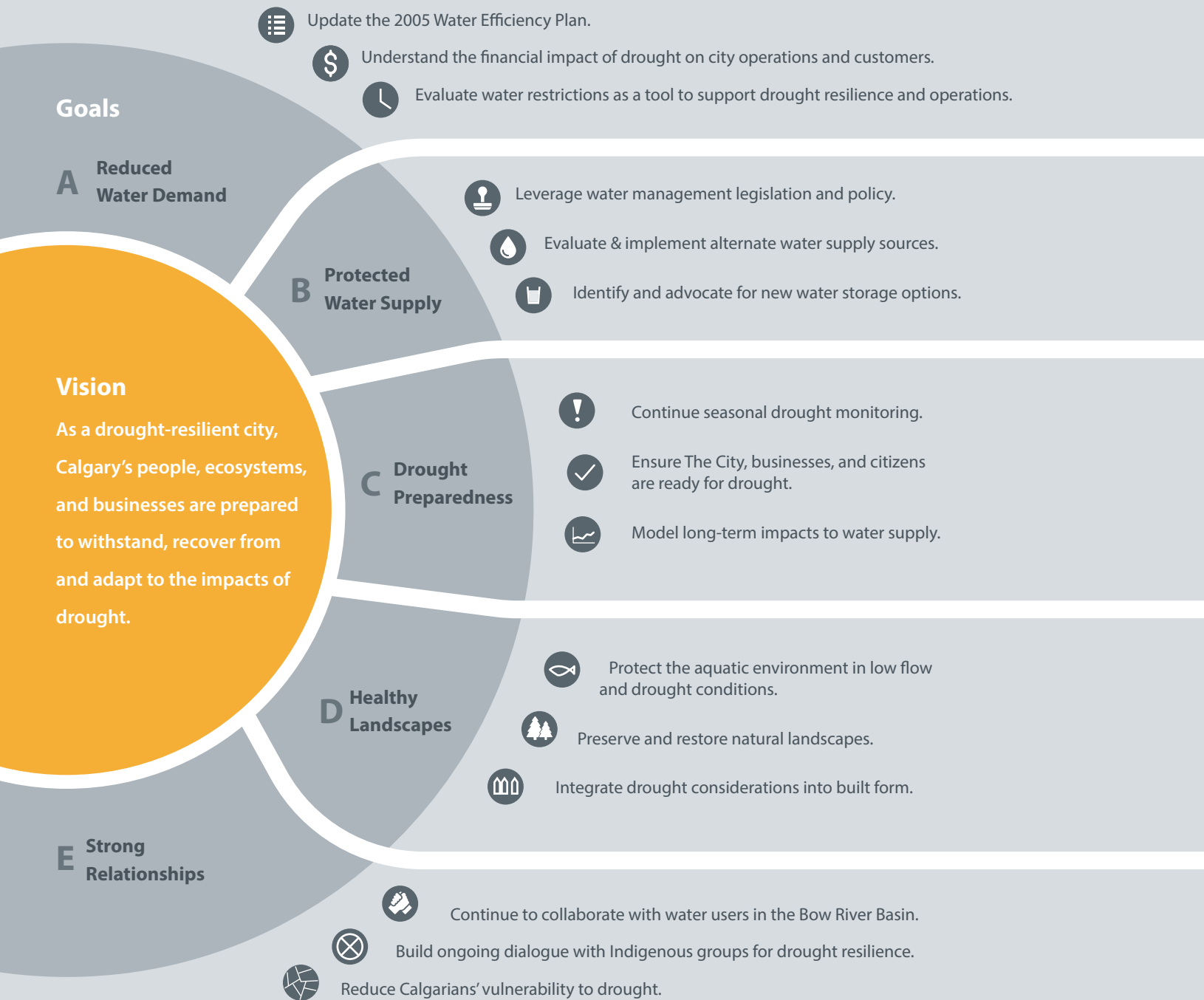
The City of Calgary uses the following definition of 'climate equity,' which is from the District of Saanich, BC:

"Climate equity means working towards the just distribution of the benefits of climate actions (mitigation and adaptation) and alleviating unequal burdens created or worsened by climate change."

For this project, equity-deserving individuals have been identified as those who might lack the means and capacity to increase personal resiliency to drought, those who may be unfairly impacted by any of the proposed drought strategies, and those who may experience increased barriers to participating in solutions. This includes, but is not limited to:

- + Low-income individuals
- + Newcomers
- + English language learners
- + Those living with mobility issues
- + Seniors (65-75+)
- + People with disabilities
- + Un/underhoused individuals

Strategic Actions



Guiding Principles



Climate Resilience

The City makes climate-risk informed drought decisions.



Water Stewardship

The City and residents have a shared responsibility to shift our relationship with water.



Equity + Inclusion

The City honours the traditional territories of the Treaty 7 Nations, Métis Nation of Alberta Region 3 and urban Indigenous Calgarians and is committed to equitable and inclusive drought planning and action.



Innovation

The City demonstrates innovation in our drought decisions and approaches.

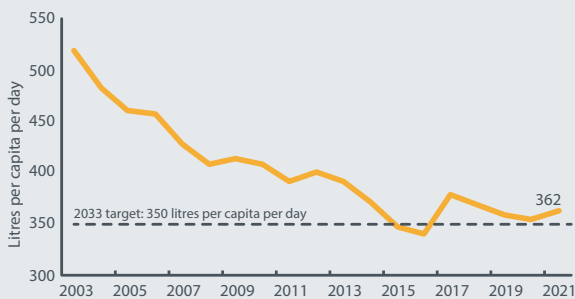
3.3 Goal A – Reducing water demand

Achieving drought resilience requires a balance of water supply and demand measures. Demand-side actions are a core pillar of drought resilience and are typically the most cost-effective and rapid means to respond in a water shortage. Maintaining a thriving city and economy in a drought-prone location requires a continuously evolving relationship with water, including further reductions to water use and demand. Investing in continued water

Calgary’s water efficiency journey: from 2005 and beyond

A key component of Calgary’s water demand goals is water conservation. Collectively, Calgarians have stepped up to the challenges to help use less water. The City’s 2005 Water Efficiency Plan guided conservation efforts city-wide and demonstrated Calgarians’ leadership in using water more efficiently. The Water Efficiency Plan’s goal is to hold withdrawals from the river steady at 2003 levels, even with population growth. With a growing population, this also meant a decrease in the amount of water used every day—expressed as litres capita per day demand—targeting a 30 per cent reduction over thirty years. Calgary is on track to achieve that goal.

Significant investments have been made towards achieving this goal, through operations, citizen education and programs and policy changes. The City also revisited its water efficiency programs in 2016, which included a shift from incentive-based programs for industrial, commercial and institutional customers to a focus on outdoor water conservation programming. Continued efforts to manage water demand—especially during the hot summer months when water use will be a core component of Calgary’s drought resilience efforts.



demand reduction efforts means using less water overall as a city, decreasing vulnerability to periods of water shortage in drought, and improving the resilience of homes, yards and businesses.

For decades, Calgarians have stepped up to the challenge of reducing city-wide water use. Since 2003, Calgary has reduced its per capita consumption by 30 per cent and is on track to reach The City’s water efficiency target of 350 litres per person per day by 2033. However, as Calgary’s population continues to grow, The City anticipates a reliance on limited water resources with a growing demand for water.

To address this risk and reduce water demand, best practice research has identified that well-developed and communicated year-round water efficiency (water conservation) programs are a key initiative, and can be scaled up or accelerated during drought periods. This way, the tools are in place and customers are already informed about the benefits of and ways to conserve water when drought conditions arise. This groundwork provides a foundation for further water use reductions during drought events.

A1 – Update the 2005 Water Efficiency Plan

The City’s Water Efficiency Plan (2005) established two key targets: 350 litres of water usage per person, per day by 2033, and a peak day demand target of remaining below 950 ML/day. These targets have served the community well by instilling a water conservation ethic in homes and businesses and enabling river withdrawals to remain at or below 2003 levels. However, Calgary’s drought risk and projected city and regional growth require us to go further as a community.

Over the next business cycle, The City will update its Water Efficiency Plan targets to align with climate and drought resiliency building efforts. Water conservation targets should align to drought response measures, operational needs, climate adaptation modelling assessments and policies. Program implementation planning and resources will be required to support residents and Industrial, Commercial, and Institutional sectors by improving access to water use data, incentives, resources and programs to reduce water use and build drought resilient landscapes. Program implementation will also strive to prioritize and mitigate unequal impacts on equity-deserving users of the water efficiency plan. A focus on outdoor water conservation programming will also help manage peak day demand, which is the one day in the year where Calgarians use the most water.



A2 – Understand the financial impact of drought on City operations and customers

Financial stability during extended drought or during multiple consecutive years of drought is a challenge for many utilities. Implementation of this plan must support a prosperous economy. Revenue-based funding for water service delivery is vulnerable to multi-year droughts because of decreased demand through curtailment measures and higher costs during drought. During drought, costs associated with staffing, infrastructure repairs, communication programs, enforcement and other associated expenses often increase, while revenues decrease as customers curtail their demands. This is an important element to consider in improving The City's overall resilience to drought. Balancing these increasing costs while maintaining accessible and affordable services for all means developing new financial approaches. A Calgary-specific study is required to quantify the financial impact of drought and to explore funding opportunities through the actions of this plan to ensure financial stability during future water shortages and to help manage peak day demand, which is the one day in the year where Calgarians use the most water.

"If the targets are [nearly] being met already then we need new ones, and to consider new and innovative practices that other cities are using for [water efficiency] programming ... it's integral for drought mitigation"

– Workshop participant



Calgarians support outdoor watering schedules

During public engagement activities (including online, in-person, through Fair Entry and at event pop-ups), The City asked Calgarians what they thought about the implementation of outdoor watering schedules as part of the Drought Resilience Plan. The concept is well supported, with 71 per cent of respondents supporting the move.

"Outdoor watering schedules should be utilized; however, they need to be reasonable in terms of maintaining usable outdoor spaces and to a watering amount that keeps the plant material and turf alive."

– from the Engage Portal

"I think it is the right thing to do and signals to citizens that we have to be more mindful of water use."

– from the pop-up booth sounding board



Image: Engagement board stationed at the Central Library.



A3 – Evaluate water restrictions as a tool to support drought resilience and operations

Calgary's water use increases on average by 20 to 40 per cent in the summer months, the same time when it is most vulnerable to the impacts of drought. This spike in demand also places additional stress on infrastructure and operations and contributes to the city's Peak Day Demand. This stress is particularly acute when there are compounding hazards of extreme heat or operational and infrastructure challenges.

While conservation programming and efforts can lessen this vulnerability, watering restrictions are often used as a complementary tool. Restrictions can help ease the demand on water supplies during peak water use periods, reduce overall vulnerability, and build customer resilience to further curtailments during drought events (Jordan et al., 2020). Restrictions can range from permanent seasonal watering schedules to temporary indoor and outdoor restrictions employed during water shortage periods or where there are strains on infrastructure and operations.

In lockstep with the other actions in this Goal, The City will explore and evaluate water restrictions, beyond what is currently permitted under the Water Utility Bylaw 40M2006, as a tool to support drought resilience and operations. It is important to understand the best approaches to utilizing water restrictions that support customers and operations, while considering impacts to finances.

Presently, The City is an outlier when contrasted with actions other communities are taking. Most communities do this already.

– Workshop participant, about water schedules

Approaches such as outdoor watering schedules would move The City closer in line with other regional and leading drought prone communities such as Airdrie, Chestermere, Okotoks, Vancouver and Denver. The concept of outdoor water schedules was well supported by citizens and businesses during project engagement and much of the input provided will help The City continue to evaluate this tactic alongside other approaches.

We heard that water schedules should be backed by proactive communications and programs that support residents to undertake this behaviour change. Success requires ongoing monitoring and awareness, with bylaw enforcement only as a final backstop.



3.4 Goal B – Protecting water supply

Drought-resiliency requires The City of Calgary to protect and preserve existing water supplies so that they remain available to meet the essential needs of institutions, communities, businesses and individuals during drought, as well as abiding by in-stream flow targets and without compromising the health and ecological integrity of our rivers, creeks and wetlands. This protection can be further increased by ensuring that Calgary has a diverse portfolio of water supplies. Securing and diversifying water supply was prioritized as the most important strategic objective during early engagement (Jacobs, 2021).



B1 – Leverage water management legislation and policy

The City will continue to work with other major licence holders across the basin and The Government of Alberta to maximize the use and flexibility of the Water Act water management tools to protect essential water supply during drought. A collaborative approach was re-enforced during the Alberta Water Council (AWC) South Saskatchewan River Basin (SSRB) Drought Simulation Exercise event that was held on June 10th, 2022. Actions such as enabling voluntary water licence assignments with Government of Alberta support, were key to the successful drought management results seen in the exercise. The Drought Simulation Exercise also identified opportunities to address gaps in understanding of apportionment, water transfers, how the Government of Alberta might exercise authority to override the priority system and assign water through emergency measures in extreme drought through a collaborative approach with water users (Sturgess, 2022).

The City of Calgary strategically manages our own water licences. The City will engage with the Province and other partners as part of this process with continued focus on collaboration during water shortage conditions.



B2 – Evaluate and implement alternate water supply sources

Leading drought-resilient cities conserve, protect and diversify their water supplies by collecting, treating and reusing water on site while matching water quality to water use. Reusing water and reducing the intensity of water treatment ensures that supply is used effectively. For example, stormwater can be used for many irrigation needs instead of fresh treated drinking water.

One of the critical elements for drought-resiliency in Calgary is developing a comprehensive water reuse strategy that addresses the use of stormwater, rainwater, wastewater plant effluent, greywater and on-site reuse. Importantly, the reuse strategy

should aim to build resiliency in the system during drought, not solely as a means of increasing overall supply. The City of Calgary already assumes responsibility for authorizing water reuse projects case-by-case. Working collaboratively with regulating authorities and assuming a greater leadership role in regulating water reuse recognizes The City's strengths, accountability and shared interests with the Province.



B3 – Identify and advocate for new water storage options

Climate change will increase the frequency and magnitude of both flooding and drought in southern Alberta. New storage solutions will help ensure a secure water supply that supports long-term regional growth while managing flood and drought risks in a changing climate.

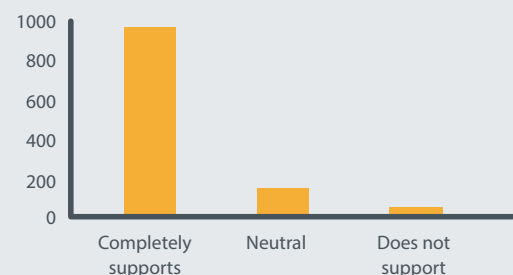
A new reservoir on the Bow River remains a critical component of upstream storage for flood mitigation, water supply and climate change resilience for Calgary and downstream communities on the Bow River. As part of Phase One of the provincial Bow River Reservoir Options study, potential water supply benefits provided by a new reservoir are also being examined.

Phase Two of the study is now underway and expected to be completed in 2023, followed by a report to be released by the province. Through the Government of Alberta's Bow River Working Group, The City of Calgary remains a key interested party and will continue to monitor the progress of the Bow River Reservoir Options study.

Calgarians support water reuse

Water reuse was prioritized as the top strategy for drought resilience from the suite of actions presented during public engagement.

Public support for water reuse



3.5 Goal C – Preparing for drought



C1 – Monitor for drought

Drought is known as a “creeping phenomenon.” It is difficult to define and measure, slow to develop, continuous, cumulative and long-lasting. As such, efforts to strengthen monitoring approaches are critical for drought preparedness and response (Agriculture Canada, 2022).

The two main tools used to define and measure drought are indicators and triggers. Indicators are variables or parameters used to describe drought conditions (McGehee & Srivastava, 2019), such as precipitation, temperature, evapotranspiration, soil moisture, stream-flow, lake levels, groundwater levels, snow-pack and drought indices (numerical representation of drought intensity). Triggers are defined as “thresholds of an indicator or index that initiate and/or terminate actions of a drought management plan” (McGehee & Srivastava, 2019, p.11); they can be physically derived or index derived and are specific values.

Suitable indicators and triggers are crucial to drought operational response as they signal the onset of a drought and its potential severity. The City monitors watershed conditions year-round, with increased monitoring from mid-May to mid-September when there is an increased risk of flooding and drought. Local indicators (including precipitation, temperature, stream-flow, lake and reservoir levels, snow-pack, water demand and drought index records and forecasts) help predict if a drought may happen and how severe it could become. Indicators are assessed against triggers to determine the appropriate drought response phase.

Continued refinement of Calgary’s drought triggers and indicators to inform proactive drought response and decision making is a priority action.



C2 – Ensure The City, businesses and Calgarians are ready for drought

Sound and comprehensive drought monitoring is critical to establish the conditions for drought actions. But equally important is the need for clear plans, communications and procedures for response – both leading up to, during and after times of water shortage. The Alberta Water Council provides a starting point for these discussions with their drought-resiliency guide that outlines strategies for before, during and after drought, as well as identifying early warning signs.

The City’s current Drought Operations and Response Plan identifies corporate-wide actions, public communications and potential watering restrictions stages, as well as long-term operations and infrastructure plans, policies and procedures that support the water utility’s ability to provide service. Updating this Drought Operations and Response Plan will increase resiliency to drought by establishing clear guidelines and processes to ensure The City can respond to future drought events efficiently and proactively.

Continued coordination between the City of Calgary business units is key to build corporate resilience to drought conditions for operations, infrastructure and assets. For example, The City will ensure that its water and wastewater treatment plant operators have operational guidelines for droughts conditions. It will also coordinate with emergency management authorities to align responses for integrated drought hazards, including wildfire response, drinking water safety and extreme heat emergency response.

Lastly, The City will strive to maintain Calgarians’ trust in its ability to manage drought, through proactive public communications about drought in Calgary.

Confidence in The City’s ability to manage in drought is directly related to clear, timely & proactive communication.

– Probe Research, 2021



Sufficient
Warning



Proactive
Communication



Clear
Instruction



C3 – Model long term climate impacts to water supply

As a warming climate amplifies regional weather extremes, droughts and other climate hazards will exceed historical experiences and challenge existing policies, structures and systems (Canada Climate Region Report). Partnering with academia, community, Indigenous communities and other organizations will be imperative to continue to build a strong understanding of drought and climate modelling, drought impacts, vulnerabilities and resilience measures. Modelling climate impacts to water supply will support adaptive management of drought monitoring, decision making and response efforts in the long term. There remains an opportunity to further strengthen this knowledge base by accessing and integrating local knowledge, specifically from equity deserving groups and Indigenous Knowledge and perspectives.

Calgary's watershed monitoring program + drought operations and response plan

Building resiliency to flood and drought is a top priority for The City as climate modelling tells us that Calgary will experience more severe and frequent extreme weather events such as flooding and droughts. The City monitors watershed conditions year-round and increases monitoring from mid-May to mid-September when there is an increased risk of flooding and drought.

City experts look at local indicators to help predict if a drought may happen and how severe it could become. The information collected through monitoring helps us carefully manage water storage at the Glenmore Reservoir and other City-owned infrastructure. The City also collaborates with the Government of Alberta and partners such as TransAlta and downstream Irrigation Districts to manage water supply and demand along the Bow River.

In the event of a drought which presents significant water supply shortages, The City has a four-stage response plan for implementing mandatory water restrictions. Watering restrictions are implemented through The City's Water Utility Bylaw 40M2006 (a summary of restrictions across the drought response stages is found on the right). The City also has a public drought dial that is updated from May to September to communicate current conditions in Calgary and the planned response. The drought dial (see dial on the right), and seasonal condition updates can be accessed at calgary.ca/droughtinfo.



NORMAL	DRY	→	VERY DRY		EXTREMELY DRY	
			STAGE 1	STAGE 2	STAGE 3	STAGE 4
VOLUNTARY WATER CONSERVATION			MANDATORY WATER RESTRICTIONS			
To avoid the need to move into mandatory water restrictions, you can help conserve water by doing the following things:			During mandatory water restrictions, all residents, businesses and City operations must restrict their outdoor water as outlined below. These restrictions are enforceable by the Water Utility Bylaw.			
✓ Water early in the morning, before the heat of the day.	YES		YES	YES	NO	NO
✓ Use a soaker hose, drip irrigation or water by hand to ensure water reaches the plant's roots.	YES		YES	YES	NO	NO
✓ Keep your lawn at least 2 or 3 inches high to shade the soil.	YES		YES	YES	NO	NO
✓ Add mulch around trees and shrubs to retain moisture and keep an even soil temperature.	YES		YES	YES	NO	NO
✓ Capture free rainwater in a rain barrel and use it for your garden.	YES		YES	YES	NO	NO
✓ Use a broom to avoid washing your sidewalks, driveways or siding.	YES		YES	YES	NO	NO

3.6 Goal D – Protecting, preserving and creating healthy landscapes

In this plan, ‘landscapes’ describe Calgary’s waterways and its natural and built assets. This goal area focuses on the important links between land, water and the impacts of an integrated watershed approach on the built environment. It is imperative that Calgary continues to grow in a way that respects and reflects future environmental flows, minimizes development impacts to water and land and improves and protects existing ecosystem services from undisturbed natural landscapes. Collectively, these efforts can help ensure that built and natural landscapes are resilient to drought and continue to offer important climate adaptation benefits.

“Landscapes will be a very visible indicator of the city’s changing moisture regime. Yellow leaves, infestations of pests, etc. Drought will have significant impact.”

– Workshop participant

From incentives to regulations: tools to encourage more drought-resilient landscapes

Water wise landscaping incentives and requirements that encourage more native and drought-tolerant plant species and other resilient landscaping features will help Calgary use less water and decrease pressure on the rivers. Other benefits include:

- + Builds more drought-resilient communities with yards and gardens that are better designed to thrive during a drought.
- + Reduces outdoor water use.
- + Increases biodiversity and supports pollinators.
- + Provides financial assistance to help Calgarians to make more water wise landscaping choices.

Building on existing programs like Calgary’s YardSmart initiative, the Drought Resilience Plan will drive forward new proactive strategies to help homes, businesses and park spaces adapt to using less water while still thriving in a drier climate.



D1 – Protect the aquatic environment in low flow and drought conditions

Low flow conditions in the Bow and Elbow rivers increase the sensitivity of the aquatic environment to wastewater (Bow River) and stormwater inputs. Environmental flows are highlighted as having high vulnerability to multi-year drought; failing to address this vulnerability is likely to lead to decreased water quality, reduced biodiversity and influx of invasive species. Three focus areas will be important to address this challenge.

Modelling as a means to understand risk

The City must increase its capacity to respond to changing stream and ecosystem requirements during low flow and drought conditions. To do so, we must further our understanding of impacts to fish habitat and water quality in the Bow and Elbow Rivers under low flow and drought conditions. This includes examining the effects of water quality constituents including dissolved oxygen, water temperature and critically, un-ionized ammonia, which is currently the primary driver of minimum river flow requirements during drought conditions in the Bow River. This, and further modelling and analysis work is necessary to better understand our risk and potential mitigation actions.

Optimize operations and consider long-term infrastructure investments

The City must also optimize operations to minimize impacts on the aquatic receiving environment. This includes ongoing efforts to monitor and optimize wastewater treatment operations as part of drought and low flow response. New infrastructure investments in both stormwater and wastewater infrastructure must also consider low flow conditions into the future to increase our ability to mitigate the impacts of drought.

Advocacy for policy change

Calgary will continue to play an advocacy role for policy change around in-stream flow protection to help ensure the aquatic environment is protected in times of drought. This may require partnerships, policies and license conditions not yet in place.



D2 – Preserve and restore natural landscapes

Calgary's natural infrastructure includes natural areas such as riparian areas, forests, creeks, and wetlands as well as engineered resources including green stormwater infrastructure. Natural infrastructure builds The City's resilience to the impacts of drought and climate change, while also being vulnerable to the impacts of drought itself. The City's drought risk and vulnerability assessment identified that drought could have impacts on the functioning of green stormwater infrastructure and wetlands during long durations of high temperatures, low precipitation, or low streamflow.

Natural infrastructure must be preserved and restored, so that ecosystem services can continue to reduce climate related risk into the future. This involves protecting our existing natural areas and assets through our planning and city building efforts. This will require strengthened environmental policies for retaining and preserving our natural areas through our planning and city building efforts. Equally, The City must work to restore, implement, monitor and adaptively manage natural infrastructure to ensure these systems remain resilient to drought. The City will support development of drought-resilient natural infrastructure design guidelines, including plant selection, maintenance and irrigation.

The value of restoring riparian areas

Riparian areas are the areas of land found along the edges of rivers, creeks and other waterbodies. They are natural assets that provide many ecological, social and economic benefits including water quality protection, resilience to flood and drought, biodiversity enhancements and recreational opportunities. Riparian restoration projects lead to a more resilient natural infrastructure that provides protection against floods and erosion and improves water quality. Through The City's Riparian Action Program, efforts continue to improve riparian health and restore riparian areas through bioengineering and riparian planting projects. Bioengineering is an approach to riverbank engineering that incorporates living plants with natural and synthetic support materials to stabilize slopes and reduce erosion. Riparian planting projects use native vegetation with deep-rooted plants that stabilize riparian areas. (The City of Calgary, 2017)

Valuing Calgary's natural assets

Investments in natural infrastructure can have significant economic returns, many of which The City is only now learning to measure. It can reduce reliance on costly built infrastructure and can support climate mitigation and adaptation. Natural infrastructure provides spaces for community connection and recreation and serves to improve Calgary's livability.

A Natural Assets Valuation for The City of Calgary was completed in 2021, demonstrating that natural assets provide significant value in the range of \$2.5 Billion annually. (The City of Calgary, 2021; Associated Engineering Alberta Ltd., 2021)

Priority Services	Recreation	Amenity & Enjoyment	Habitat	Water Retention	Urban Heat Reduction	Carbon Storage	Total
Annual service value	\$899 Million	\$50 Million	\$33.7 Million	\$1.2 Billion	\$381 Million	\$1.8-\$7.6 Million	\$2.5 Billion



D3 – Integrate drought considerations into the built form

Urban form influences water use in significant ways, driven by building codes and landscaping choices (American Planning Association (APA), 2019). Integrating drought adaptation measures into municipal and regional planning processes and decisions is an effective way to advance drought awareness, bring resources together, and set systems in place before the onset of a severe water shortage (APA, 2019). This early integrated planning can also build community resilience and facilitate a more rapid recovery from drought and other related hazards (APA, 2019). Including drought landscaping standards in The City's planning policies and

regulations will encourage development of drought and climate resilient communities and neighbourhoods. Through the Land Use Bylaw renewal and City Building program, an opportunity is presented to update landscape regulations to encourage and require more native and drought-tolerant plant species and other resilient landscaping features, supporting better outcomes for drought resilience on private landscapes. There is also opportunity to ensure drought considerations (including demand, supply and preparedness goals) are incorporated in The City of Calgary water, wastewater and stormwater technical specifications and guidelines. Likewise, The City can identify opportunities for improvement in policy and technical guideline coordination between various government organizations, regional growth and service plans and land use plan policies related to water efficiency, drought adaptation and drought response.

"Ensuring we have the policies in place to regulate land use and support appropriate uses of land that minimize water consumption and ecological disruption is critical to ensure future development decisions support rather than harm water security."

- Workshop participant



3.7 Goal E – Strong relationships

Drought is not a localized hazard. Drought is widespread and has impacts much broader than Calgary's city limits. Because of this, resilience-building efforts necessitate a collaborative and watershed-scale approach shared by The City and other Bow River water licence holders, regional neighbours and all Calgarians.

The strong relationships goal provides focus for collaboration and working with others in the region, as well as ensures The City supports equitable outcomes for individuals and communities before, during and after times of drought.



E1 – Collaborate with water users in the Bow River Basin

The City is part of a network of water users across the watershed. As a major licence holder on the Bow River, and as a water service provider to neighbouring regional municipalities, it holds a unique position and responsibility to be a leader in drought response and resilience-building measures. As part of this responsibility, The City can and should promote innovation, data sharing and collaboration to manage water supplies in a coordinated fashion.

The City will continue to participate in the Major Water Users Group, with the Province, Irrigation Districts and TransAlta and advocate for continued policy coordination for drought response. It will also continue to review Master Servicing Agreements with regional customers to ensure alignment with drought planning and response measures, and continue to collaborate with the Bow River Basin Council, watershed stewardship groups and municipalities up and down-stream. Opportunities to participate in water security-related steering committees, advisory groups, or pilot projects will be actively pursued for knowledge and capacity-building across the watershed.

"Southern Alberta has a history of working together through drought; we should honour and build on that."

– Workshop participant



E2 – Build ongoing dialogue with Indigenous groups for drought resilience

Guided by Calgary's White Goose Flying Report (The City of Calgary, 2016) which directs The City of Calgary's responsibilities, commitments and actions for advancing truth and reconciliation, a series of Indigenous Summits focused on the topic of water, land and climate are underway. Rooted in respect, relationship building and ethical-space, these Summits have provided a space for Elders, Knowledge Keepers and members of Treaty 7 Nations, Métis Nation of Alberta Region 3 and urban Indigenous Calgarians to share concerns, priorities and stories with City staff. These summits provide a foundation for relationship building and a pattern of ongoing conversations about water.

Drought has emerged as a topic of shared concern and priority. The interconnectedness of water with everything around us underpins this concern. As Calgary advances drought resilience actions, it is imperative we think about responsibilities to the water itself, to the animals and plants that depend on it and to those that share the water upstream and downstream of us.

Communities have emphasized the legacy of colonization and the impacts of treaty-making on the inherent rights of Indigenous peoples, particularly with regards to their relationship with water. The signing of Treaty 7 has had profound consequences for Indigenous communities' access to and management of water resources, often undermining their traditional practices and knowledge.

As we face the challenges brought by climate change, it is crucial to acknowledge the disproportionate impacts felt by Indigenous communities. Indigenous Peoples have been stewards of these lands for countless generations, with deep understanding of the environment and its interconnectedness. Prolonged droughts, unpredictable weather patterns, and diminishing water sources will further jeopardize the delicate balance of ecosystems and the livelihoods of Indigenous Communities.

In light of this, we recognize the imperative to find opportunities for place-based, context specific integration of Indigenous Knowledge, priorities and practices to shape our actions in managing drought and water resources. As a community, we can benefit from the wisdom of Indigenous Peoples in developing holistic and sustainable approaches to drought resilience.

We commit to fostering meaningful partnerships and collaboration with the Blackfoot, Îethka Nakoda Wicastabi, Tsuut’ina and Métis Nations and urban Indigenous communities. This includes actively involving them in decision-making processes, engaging in knowledge exchange and recognizing their expertise in local environmental knowledge and adaptation strategies. We also commit to building ongoing dialogue with Indigenous communities upstream and downstream during drought.

Furthermore, we acknowledge the need for ongoing education and awareness about the historical and ongoing injustices faced by Indigenous communities. We strive to create spaces that honor and respect indigenous cultures, traditions, and perspectives, promoting reconciliation and healing.

This goal serves as a reminder that our efforts to address drought and climate change must be grounded in respect for the rights, knowledge, and priorities of Indigenous Peoples. Together, we can work towards a future that honors the land, sustains our water resources, and upholds justice for all.



E3 – Reduce Calgarians’ vulnerability to drought

Certain groups and individuals will face disproportionate challenges coping with and responding to the impacts of drought. As climate impacts and the impacts of drought intensify, it is necessary for climate adaptation plans, policies and tools to acknowledge differences in how people will experience and respond to these impacts and plan to address these gaps in an equitable manner.

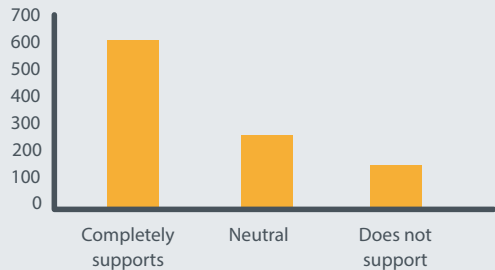
Across our five goal areas, various tools, policies and programs are identified to advance our drought-resilience efforts within our community and across the watershed. It is imperative that as these actions are advanced, potential disproportionate impacts to equity-deserving group are identified and mitigated. Purposeful engagement and community partnership efforts will target underrepresented and equity-deserving groups, leverage existing community networks and provide tools to support community participants.

Calgarians support equity-centred programs

We asked Calgarians whether The City should prioritize programs that support vulnerable populations as we advance our Drought Resilience Plan. The answer is Yes!

“This should be a very high consideration when it comes to any subsidies and rate changes. Additionally, prioritizing education for underserved groups is a good way to make sure no one is left behind.”
Engage Portal response

Public Support for Equity Programs



3.8 Implementation timeline & status

	Status	Planning Horizon	Climate Strategy - Adaptation Themes Alignment			
	Not Started In development: action is being prepared for implementation In progress: action is currently being implemented	Short Term: 2023-2026 Mid Term: 2026-2029 Long Term: 2029+ Ongoing *Term = action duration + implementation. Mid + long term actions may include exploratory work over the coming business cycles.	People	Built Infrastructure	Natural Infrastructure	Water
	REDUCED WATER DEMAND					
	Update the 2005 Water Efficiency Plan	In development	Short Term			x
	Understand the financial impact of drought on city operations and customers	Not started	Short Term	x	x	x
	Evaluate water restrictions as a tool to support drought resilience and operations	In development	Short Term			x
	PROTECTED WATER SUPPLY					
	Leverage water management legislation and policy	In progress	Mid Term			x
	Evaluate and implement alternate water supply sources	In development	Long Term		x	x
	Identify and advocate for new water storage options	In progress	Ongoing			x
	DROUGHT PREPAREDNESS					
	Continue seasonal drought monitoring	In progress	Ongoing	x		x
	Ensure the city, businesses and Calgarians are ready for drought	In progress	Ongoing	x	x	x
	Model long-term impacts to water supply	In development	Mid Term			x
	HEALTHY LANDSCAPES					
	Protect the aquatic environment in low flow and drought conditions	In progress	Mid Term		x	x
	Preserve and restore natural landscapes	In development	Ongoing		x	x
	Integrate drought considerations into built form	Not started	Mid Term	x	x	x
	STRONG RELATIONSHIPS					
	Continue to collaborate with water users in the Bow River Basin	In progress	Ongoing	x		x
	Build ongoing dialogue with Indigenous groups for drought resilience	In development	Ongoing	x		x
	Reduce Calgarians' vulnerability to drought	In development	Ongoing	x		x

3.9 Conclusion

Calgary's commitment to drought-resilience is not taken lightly. Without proper preparedness and forethought, the potential risks and impacts of drought to Calgary from a climate change are substantial. Fortunately, The City's commitment to drought resilience is comprehensive and multi-faceted. Framed within The City's vision for a drought-resilient city, the Drought Resilience Plan clearly identifies specific goals, including Reducing Water Demand, Protecting Water Supply, Preparing for Drought, Supporting Healthy Landscapes and Building Strong Relationships that collectively address and build capacity for drought-resiliency.

All Calgarians have a role to play in building a more drought-resilient city. The Drought Resilience Plan provides a framework for building resilience. The actions and initiatives identified will make Calgary more adaptable in the face of drought, helping the city better withstand, endure and recover from extended periods of dry weather.



Glossary

Term	Definition	Reference
30-in-30	Water conservation goal adopted by City Council in December 2005.	The City of Calgary, 2007
Drought adaptation	Refers to the actions, policies, programs, tools and strategies intended to reduce the negative impacts of drought on our city's infrastructure, natural assets, economy and people.	The City of Calgary, 2022
Alternate water supply	See 'water reuse.'	
Climate equity	See 'equity.'	The City of Calgary, 2022
Climate modelling	Simulations of a future climate using computer models and emissions scenarios.	The City of Calgary, 2022
Ecosystem service	The benefits people obtain from nature. These include provisioning services such as clean water supplies, regulating services such as flood and disease control and cultural services such as spiritual, recreational and cultural benefits.	The City of Calgary, 2018
Environmental flows	The quantity, timing and quality of water flow required to sustain freshwater ecosystems and the human livelihoods and well-being that depend on these ecosystems.	Government of Alberta, 2022a
Equity	Conditions are adjusted to meet people's diverse needs, strengths and social realities. It requires recognition that different barriers (often systemic) exist for diverse individuals or groups. The result of equity is all people have the opportunity to benefit equally from City services.	The City of Calgary, 2022
Greywater	Household wastewater from washing machines and bathtubs. It does not include wastewater from toilets, urinals or kitchen sinks.	Government of Alberta, 2022b
Drought hazard	The potential occurrence of a drought-driven event or trend that may cause loss of life, injury, or other health impacts, as well as damage or loss to property, infrastructure, livelihoods, service provision, ecosystems and environmental resources.	The City of Calgary, 2022
Drought impact	The adverse effects of drought-related acute events or long-term trends on the human-valued attributes of built, natural and human systems. The magnitude of impact(s) is dictated by the event and/or trend itself, the vulnerability of the systems impacted based on their sensitivity and response capacity and the exposure of the system affected.	The City of Calgary, 2022
In-stream flows	The quantity, timing and quality of water flow required to sustain freshwater ecosystems and the human livelihoods and well-being that depend on these ecosystems.	Government of Alberta, 2022a

Term	Definition	Reference
Litres per capita	Water use per person, per day. It is calculated based on average day demand (i.e. the average volume of water used per day), divided by the population served. Municipalities typically express per capita demand as either gross per capita demand or residential per capita demand, depending on the population they're describing.	The City of Calgary, 2007
Multi-year drought	A prolonged period of depleting water resources that lasts more than one year.	
Natural asset	Assets that rely on ecological and hydrological processes to provide municipal, ecosystem and societal services. This includes grasslands, forests, riparian areas, watercourses and wetlands.	The City of Calgary, 2021
Natural infrastructure	Includes the preserved and restored natural areas in our city, such as grasslands, forests and waterbodies, as well as the green stormwater assets built to use natural processes to manage water and provide ecosystem functions in an urban environment, such as constructed wetlands, rain gardens and green roofs.	The City of Calgary, 2022
Peak day demand	The day with the largest total water use experienced by a water supply system within a single calendar year. This is determined based on the total volume of water produced on a single day.	The City of Calgary, 2007
Drought resilience	The ability of social, economic and environmental systems to cope with a drought-driven hazardous event, trend or disturbance, responding or reorganizing in ways that maintain their essential function, identity and structure while also maintaining the capacity for adaptation and transformation.	The City of Calgary, 2022
Stormwater	Rain, melting snow and ice that washes off driveways, parking lots, roads, yards, rooftops and other surfaces.	
Vulnerability	The degree to which a system may be adversely affected; vulnerability encompasses a variety of concepts including sensitivity or susceptibility to harm and system response capacity.	The City of Calgary, 2022
Wastewater	Water that carries waste from homes, businesses and industries to wastewater treatment plants.	The City of Calgary, 2007
Water demand	Volume of water used in a day.	The City of Calgary, 2007
Water efficiency	The act of using a minimal amount of water to accomplish a function, task, process or result. For example, using less water when taking a shower.	The City of Calgary, 2007
Water license	To divert and use surface or ground water in Alberta requires a licence under the province's Water Act. The licence identifies the water source, location of diversion site, volume, rate and timing of water to be diverted, priority of the "water right" established by the licence, and any conditions the diversion must adhere to.	Government of Alberta, 2021a

Term	Definition	Reference
Water restrictions	City of Calgary water restrictions are outlined in the Water Utility Bylaw. The bylaw outlines four stages of mandatory restrictions based on the severity of the water shortage.	
Water reuse	When water is used again after its original intended purpose. The reuse can be for the same or a new purpose, and includes alternative water sources such as wastewater, greywater, and rainwater.	Government of Alberta, 2021b
Water security	Having enough safe water for human well-being, ecosystem resilience and economic activities now and for future generations.	The City of Calgary, 2019
Water supply	Quantity and timing of water in its natural or raw state available for withdrawal, treatment, and distribution.	The City of Calgary, 2018

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