

GREEN SKY
SUSTAINABILITY

Climate Change Adaptation Plan *for* **Town of Altona**



PREPARED FOR:
TOWN OF ALTONA

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EXECUTIVE SUMMARY

The Town of Altona is experiencing climate-related impacts that are already affecting infrastructure reliability, service continuity, and community well-being. This Climate Change Adaptation Plan provides a structured approach to reduce risk, strengthen resilience, and guide municipal decision-making in response to evolving climate hazards. It identifies priority risks and outlines practical actions that can be integrated into existing municipal planning, operations, and capital investment processes.

Purpose and Scope

This Plan supports the Town's long-term resilience by identifying climate hazards most relevant to Altona, assessing risks to critical municipal systems and community services, and prioritizing adaptation actions for near-, medium-, and longer-term implementation. The Plan focuses on practical measures that strengthen infrastructure performance, reduce service disruptions, and support community preparedness.

Engagement and Inputs

Development of the Plan was informed by two complementary engagement activities:

- **Community Survey:** A public survey was designed to gather residents' lived experience of climate-related events and understand the hazards that community members are most concerned about. The survey was implemented by the Town's Manager of Community Services and promoted through digital channels, paid local advertising, the Town website, and an in-person display at the Altona Community Meal to support broad accessibility and participation.
- **Risk Assessment Workshop (Day 2):** A facilitated workshop with Town staff and stakeholders applied local operational knowledge to identify and prioritize climate risks across municipal infrastructure, critical services, and community well-being.

Together, these activities provided both community-informed insight and operational perspective to inform climate risk priorities and recommended adaptation actions.

Priority Climate Hazards

The Plan focuses on four climate hazards expected to drive the greatest risk for the Town of Altona:

- Flooding / Extreme Rainfall
- Drought and Extreme Heat
- Gusty Winds and Tornadoes
- Air Quality (Wildfire Smoke)

Key Risks and Vulnerabilities

The assessment identified a combination of infrastructure-driven and service-driven risks. The most significant risks include:

- Flooding impacts on underground infrastructure, particularly sanitary systems. Extreme rainfall events can increase infiltration and inflow, contribute to lift station capacity challenges, and elevate the risk of backups and localized flooding.
- Stormwater system capacity constraints and surface flooding. Intense rainfall can exceed stormwater drainage capacity and create overland flow issues that affect roads, buildings, and public safety.
- Heat and drought impacts on community well-being and essential services. Longer dry periods and higher temperatures can increase health risks for vulnerable populations and affect service continuity and facility comfort, while increasing pressure on water planning and demand.

- Severe wind impacts through power disruptions and cascading service interruptions. High-wind events create risk of localized damage, debris hazards, blocked access routes, and outage-related disruption to services.
- Wildfire smoke and reduced air quality affecting health and outdoor programming. Smoke events can limit safe outdoor activity, increase respiratory health risks, and require operational readiness for clean-air spaces and communication protocols.

Cross-cutting vulnerabilities that increase overall climate risk include aging infrastructure systems (particularly underground networks), dependencies on power and transportation access, and heightened sensitivity among vulnerable residents, including seniors, individuals with chronic illness, and households with limited resources to adapt.

Strategic Directions

The Plan organizes adaptation priorities into five Strategic Directions that guide action planning and implementation:

1. Protect Community Well-Being and Support Vulnerable Populations
2. Build Governance, Capacity, and Collaboration
3. Strengthen Flood and Stormwater Resilience
4. Ensure Long-Term Water Security
5. Enhance Natural Assets and Green Infrastructure

Priority Actions (Near-Term Focus)

The Plan identifies a broad set of adaptation actions, with near-term priorities focused on measures that deliver immediate risk reduction and strengthen operational readiness. Key near-term priorities include:

- Stormwater and overland flow improvements in known flood-prone areas
- Sanitary system upgrades and strategies to reduce infiltration and inflow during major rainfall events
- Risk-informed maintenance and capital planning for critical underground infrastructure
- Extreme heat preparedness measures, including public messaging and targeted support for vulnerable groups
- Planning for clean-air spaces and operational protocols during wildfire smoke events
- Strengthened outage response planning, communications readiness, and emergency coordination for severe storms

Medium- and Long-Term Priorities

Beyond near-term actions, the Plan outlines medium- and long-term priorities to strengthen infrastructure resilience, integrate climate considerations into municipal decisions, and enhance ongoing community preparedness.

Medium-term priorities (2–5 years) include:

- Advance prioritized stormwater and sanitary system upgrades in high-risk areas, based on observed flooding, infiltration and inflow, and system performance trends.
- Complete targeted technical studies and designs as needed to support future capital projects and refine cost estimates.
- Integrate climate risk considerations into asset management, capital planning, and facility renewal to guide investment decisions.

- Expand the use of nature-based solutions, including tree planting, permeable surfaces, and rain gardens, to improve drainage, cooling, and livability.
- Strengthen emergency preparedness and service continuity planning by ensuring backup power for critical facilities and refining severe weather response protocols.

Longer-term priorities (5+ years) include:

- Implement larger-scale stormwater and sanitary infrastructure upgrades to address capacity constraints and reduce flood risk.
- Continue renewing aging underground infrastructure, incorporating climate resilience into design standards and procurement practices.
- Sustain improvements in community preparedness for heat, smoke, and extreme weather through facility upgrades, enhanced communication systems, and partnerships.
- Maintain ongoing monitoring and periodic updates to the Adaptation Plan to reflect changing climate conditions, new data, and implementation progress.

Implementation Approach

Implementation of this Plan will require coordination across departments and alignment with existing municipal planning tools. The Plan is designed to be actionable and can be advanced through:

- Integration into capital planning and asset management processes
- Annual work planning and budgeting for priority actions
- Partnerships with external agencies, community organizations, and regional stakeholders
- Monitoring and periodic updates to reflect new data, evolving hazards, and implementation progress

Conclusion

This Climate Change Adaptation Plan provides a practical pathway for the Town of Altona to reduce climate risks, strengthen resilience, and protect community well-being. By focusing on high-priority hazards such as flooding, heat, severe storms, and wildfire smoke—and by implementing targeted near-term actions while embedding climate considerations into long-term planning—the Town will be better positioned to maintain reliable services and respond effectively to changing climate conditions.

1. INTRODUCTION

1.1 Vision of Altona for a Resilient Future

Altona is a safe, sustainable, and forward-thinking community where residents are protected, connected, and empowered to thrive in a changing climate. They build reliable infrastructure, maintain secure water systems, offer inclusive services, and look after their natural surroundings to help them handle severe weather. By working together and staying prepared, they protect their people, their homes, and their future.

1.2 Purpose and Scope of the Plan

This Climate Adaptation Plan establishes a structured, evidence-based framework to enable the Town of Altona to prepare for and address the impacts of climate change. The Plan identifies primary climate hazards, evaluates risks to municipal infrastructure, services, and community well-being, and proposes actionable measures to reduce vulnerability and enhance resilience in the near, medium, and long term.

The scope of the Plan includes:

- Municipal infrastructure and services, including water, wastewater, stormwater, roads, and facilities
- Community well-being
- Natural assets and green infrastructure
- Governance, planning, and emergency management functions

The Plan is designed to guide decision-making, capital planning, operations, and community engagement. While it does not replace detailed engineering studies or emergency response plans, it offers a strategic framework to inform and prioritize these efforts.

1.3 How This Plan Was Developed

The Plan was developed through an integrated process combining technical analysis, community engagement, and collaboration with municipal staff and regional partners. Key inputs included:

- Review of regional climate data and projections for southern Manitoba
- GIS-based flood and drainage modelling using high-resolution elevation data
- A community survey capturing resident perceptions and priorities
- Two facilitated workshops with municipal staff, Council members, and community stakeholders
- Review of existing municipal plans, studies, and infrastructure assessments

This approach ensured the Plan reflects both quantitative risk analysis and lived experience, grounding adaptation actions in local realities and operational capacity.

1.4 Alignment with Municipal and Regional Plans

The Climate Adaptation Plan is aligned with and intended to complement existing municipal and regional initiatives, including:

- Asset Management Planning and capital budgeting processes
- Emergency Management and Municipal Emergency Plans
- Land-use planning, zoning, and development standards
- Regional water supply and watershed management initiatives

Integrating climate considerations into these frameworks ensures alignment and avoids creating parallel or duplicative processes.

1.5 Structure of This Document

The document is organized into eight sections:

1. **Introduction** – Introduces Altona’s Climate Change Adaptation Plan.
2. **Community Context** – Describes Altona’s community, physical setting, and climate context.
3. **Community Engagement** – Summarizes community engagement activities and findings.
4. **Climate Risk and Vulnerability Assessment** – Presents the climate risk and vulnerability assessment.
5. **Adaptation Goals and Strategic Directions** – Outlines adaptation goals and strategic directions.
6. **Adaptation Actions and Implementation Plan** – Details prioritized adaptation actions and implementation pathways.
7. **Implementation and Monitoring Framework** – Establishes implementation roadmap, governance, monitoring, and review processes.
8. **Use of Artificial Intelligence** – Presents the assistance of artificial intelligence in the development of the report.
9. **Authorization** – Presents the author and reviewers of the report.
10. **Appendices** – provide technical detail, data, and supporting analyses.

2. COMMUNITY CONTEXT

Understanding Altona’s community and climate context is essential for identifying climate risks, sensitivities, and adaptive capacity. This chapter outlines the town’s geographic, demographic, economic, and infrastructure characteristics, followed by an overview of historical and projected climate conditions relevant to southern Manitoba. Together, these elements establish the baseline conditions upon which climate vulnerability and adaptation priorities are assessed.

2.1 Overview of Altona

2.1.1 Location, Population, and Key Economic Sectors

The Town of Altona is located in southwestern Manitoba, within the Pembina Valley region, approximately 100 km south of Winnipeg and close to the Canada–United States border. The town functions as a regional service and employment hub for surrounding rural municipalities, supporting both agricultural production and value-added manufacturing activities.

According to the 2021 Census, Altona has a population of approximately 4,390 residents, reflecting steady growth over recent years. Population expansion has been supported by economic diversification, relative affordability, and strong local institutions. The community includes a mix of young families, working-age residents, and seniors, each of whom experiences climate risks differently.

Altona’s economy is anchored in several key sectors that are highly sensitive to climate conditions:

- Manufacturing, including food processing and printing, which depends on reliable energy, transportation, and water systems
- Agriculture and agri-processing, reflecting the town’s location within one of Manitoba’s most productive farming regions
- Construction, driven by ongoing residential, commercial, and infrastructure development
- Health care and social services, serving both local and regional populations

These sectors contribute significantly to employment and municipal revenue but are also exposed to climate-related hazards such as heat extremes, flooding, drought, and supply-chain disruptions. As a result, climate impacts in Altona can have cascading economic and social effects beyond the town itself.

2.1.2 Geographic Setting and Infrastructure Overview

Altona is situated within the Prairie ecozone, characterized by relatively flat terrain, fine-textured soils, and a continental climate. The region is naturally prone to surface water accumulation during intense rainfall and moisture deficits during dry periods, creating dual flood and drought risks.

The town's built environment includes:

- Residential neighbourhoods with varying housing ages and construction standards
- Industrial and commercial areas, including major employers such as agri-processing and manufacturing facilities
- Critical municipal infrastructure, including water supply reservoirs, wastewater lift stations, stormwater drainage systems, roads, and public facilities
- Community services, such as schools, health-care facilities, recreational centers, and emergency services

Much of Altona's infrastructure was designed using historical climate data, assuming precipitation and temperature ranges that are no longer representative of current or future conditions. Previous engineering assessments have identified vulnerabilities in stormwater and drainage systems, particularly under extreme rainfall scenarios, where system capacity may be exceeded. These risks are amplified by aging infrastructure and long asset lifespans, often exceeding 50 years.

2.2 Climate Context

2.2.1 Historical Climate Trends for Southern Manitoba

Southern Manitoba has already experienced significant climatic changes over the past several decades, consistent with national and Prairie-wide trends. Observational records show that the region has warmed by approximately 1.5–2.0°C since the mid-20th century, with the greatest increases occurring in winter and nighttime temperatures.

Key observed historical trends include:

- Rising average temperatures, particularly warmer winters and hotter summers
- Longer frost-free and growing seasons, affecting agriculture and ecosystems
- Increased frequency of heavy precipitation events, even where total annual precipitation has only changed modestly
- Greater climate variability, including alternating periods of flooding and drought
- These changes have already influenced agricultural productivity, water management, infrastructure maintenance, and public health outcomes across southern Manitoba. Municipalities such as Altona are increasingly experiencing climate impacts that exceed historical design assumptions.
- Authoritative sources documenting these trends include Environment and Climate Change Canada and the Prairie Climate Centre, which provide regionally downscaled climate observations and analyses.

2.2.2 Projected Future Climate Conditions (Temperature, Precipitation, Extreme Events)

Climate projections for southern Manitoba indicate that future climate changes will be more pronounced than those observed to date, particularly under high-emissions scenarios consistent with current global trends.

According to projections from the Climate Atlas of Canada and the Manitoba Climate Report, the region encompassing Altona is expected to experience the following by mid- to late-century (See Appendix D for detailed projections):

- Temperature
 - Significant increases in average annual and seasonal temperatures
 - More frequent and intense heat waves, with a sharp rise in days above 30°C
 - Warmer nights, reducing opportunities for nighttime cooling and increasing heat stress
- Precipitation
 - Wetter winters and springs, increasing flood and runoff risks
 - More variable summer precipitation, with higher likelihood of both drought and intense rainfall events
 - Greater rainfall intensity during storms, placing pressure on stormwater and drainage systems
- Extreme Events
 - Increased risk of extreme rainfall and localized flooding
 - More frequent heat-related health impacts, particularly for seniors and vulnerable populations
 - Higher likelihood of severe storms, including hail and high winds
 - Indirect impacts from wildfire smoke, affecting air quality even when fires occur outside the region

Under these projections, Altona's future climate is expected to resemble the current climate of regions located significantly farther south, representing conditions the community has not historically experienced. This shift has important implications for infrastructure design, emergency management, land-use planning, and community well-being preparedness.

2.3 Local Climate Exposures and Physical Setting

The physical setting of the town and surrounding area plays a vital role in how water will accumulate and flow during storm events. Studying this area gives a clearer understanding and better representation of the likelihood and magnitude of flooding after periods of heavy rain.

2.3.1 Buffalo Creek Watershed

Buffalo Creek runs north down south-west towards the US border. It flanks Altona's North-West border and has some smaller tributaries that run closer to the town. Historically, the creek has overflowed and intensified the severity of floods during periods of heavy rainfall or snowmelt and is an important feature in flood risk assessment.

2.3.2 Flat Prairie Terrain and Runoff Characteristics

The region surrounding Altona is gently sloping and dominated by farmland; the soils surrounding the town primarily have particle sizes of clayey-clayey loam to fine loam, which is primarily clay and silt. Most of the soil falls under the general Deadhorse-Dugas-Osborn group, which are characterized as being poorly drained, resulting in the soil staying wet for a significant portion of the year. All of these factors result in a

low infiltration rate and high accumulation potential as the water does not drain away quickly. Runoff coefficients for the area were determined on this basis and can be viewed in Appendix C.

2.4 Flood and Drainage Analysis

This section evaluates flood susceptibility within Altona and the surrounding area under extreme rainfall conditions. The analysis focuses on overland flow, surface ponding, and interactions with existing drainage systems, providing a planning-level understanding of where flooding is most likely to occur and where mitigation efforts may be most effective.

Building on the physical settings outlined in Section 2.3, this analysis employed a GIS-based hydrologic modeling approach using Digital Elevation Models (DEMs) within QGIS to simulate rainfall events and assess flood prone areas in the town. The model uses an intensity of 91 mm/h for a 1-in-200 year rainfall event calculated for the town and surrounding area.

2.4.1 Modelling Methodology

The following is a summary of the methods used to model the flood susceptibility of the Town of Altona and surrounding area. This was done to identify areas of concern and assess mitigation strategies. A detailed breakdown of the steps and tools used can be found in Appendix C.

DEMs were processed to identify depressions and accumulation zones in the study area. This was done by first clipping to the area, filling any artificial sinks, and simulating flow accumulation using tools in QGIS. A landcover map of Canada was clipped to the same extent as the DEM for further analysis. Runoff coefficients were estimated based on the topography and soil characteristics and joined to a landcover map. This unitless value estimates the amount of water that will run off after soil infiltration and landcover storage has been exceeded. Depressions or areas that could accumulate water were identified using the filled DEM and converted to polygons. Using Zonal Statistics, the maximum flow accumulation and storage sum were added to this layer. The previously calculated flow accumulation was converted to points, and the runoff coefficient values were applied to these based on which cell the points fell under. These values were then joined to the polygons using the Join Attributes by Location (Summary) tool to identify the mean and maximum coefficient for each polygon. Finally, the 1-in-200 year rainfall event of 91 mm/h was used to model runoff volume (see Appendix F for the calculation details). This was done by adapting the rational method to get total runoff volume using the maximum flow accumulation, rainfall intensity for one hour, and runoff coefficient for each polygon. This value was compared to the storage infiltration capacity of each depression to estimate where ponding is likely to occur.

2.4.2 Results and Visualizations

The results are visualized in Figure 1 and Figure 2 below.

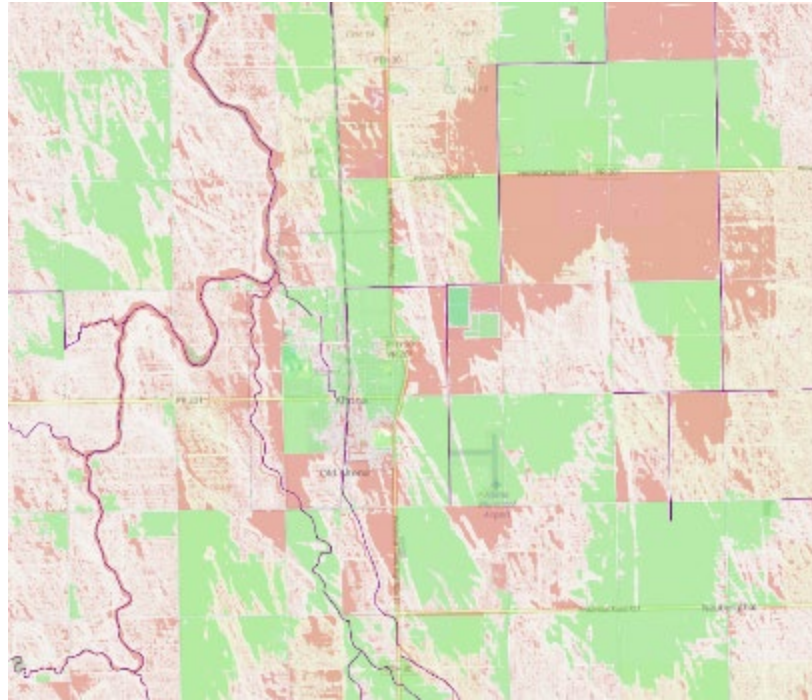


Figure 1: Flood prone zones for the greater study area, including Buffalo Creek. Red indicates areas where ponding is likely to occur, green where storage has not been exceeded and uncoloured where water is unlikely to accumulate.

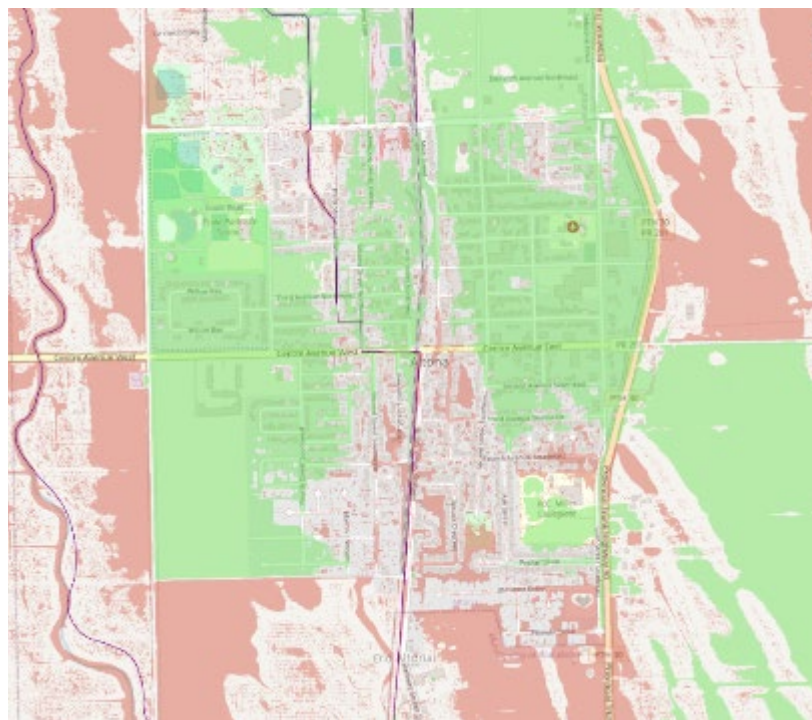


Figure 2: Flood prone zones within the Town of Altona. Red indicates areas where ponding is likely to occur, green where storage has not been exceeded and uncoloured where water is unlikely to accumulate.

The maps produced in Figure 1 and Figure 2 show areas where depressions exist and water could accumulate in red and green. The trend of the greater area shows many larger depressions where water tends to accumulate near the river and in low lying fields, whereas within the town, there are a few large green depressions and many smaller red depressions. Water overflow is concentrated along roads and between buildings, as well as in the south end of town. Below is a summary of what red and green areas indicate and results from the model.

A higher resolution image of the extent of the town can be found in Appendix C.

Red Areas

- Water overflows and moves into surrounding areas
- High-risk for spreading floodwater beyond boundaries
 - The deepest overflowing areas are along the rail line and in the southeast corner of town, with the deepest depression being ~1.6 m and the majority being well under 50 cm
 - The depressions on the west border are large and 1.3 to 2 m in depth

Green Areas

- Water will stay pooled inside these areas up to their capacity
- Act as natural storage basins, reducing downstream flooding
 - The west side of town is expected to have very shallow ponding and has a large storage capacity
 - The southeast border of town has a very large storage capacity that is hardly utilized

Figure 3 shows the flow direction layer overlaid on the depressions layer. For the most part, major flow paths are from north to south, with some spreading out west or eastward within or towards town.

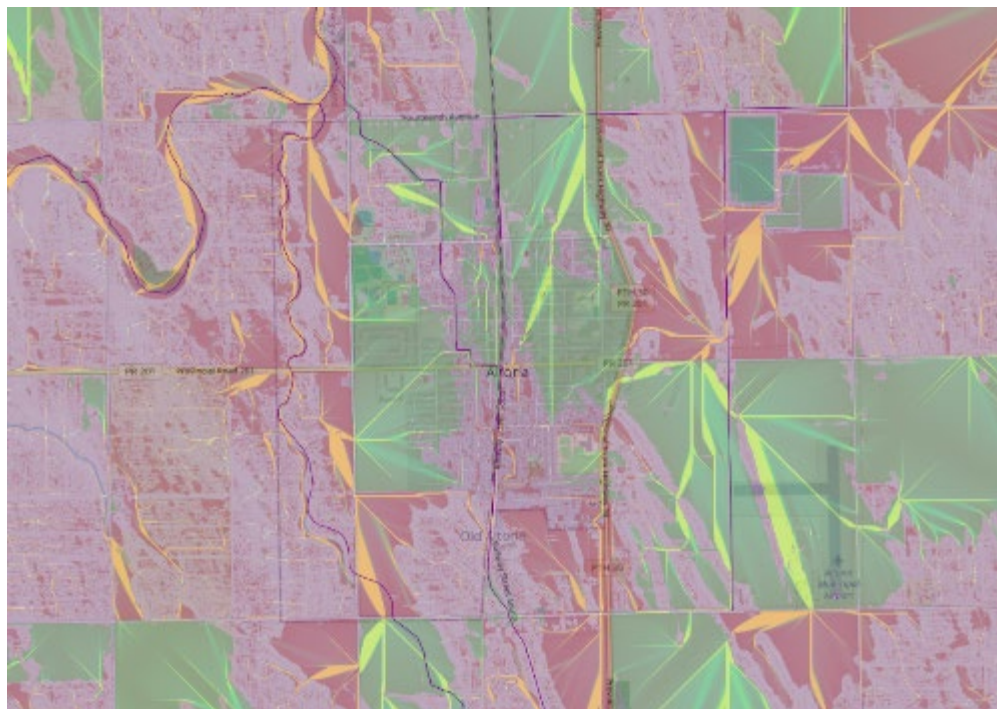


Figure 3: Direction of Flow Accumulation

2.4.3 Key Findings and Implications for Stormwater Management

The results identified a few key risk areas and opportunities for mitigation.

The major risk areas are shown in red and are mostly concentrated at the edges of town and in the south end. These areas are critical for planning drainage improvements or flood protection as they require additional storage solutions or enhanced conveyance systems. Such examples include detention ponds, retention basins, storm sewers and channels.

Green areas are potential sinks for redirecting storm water, however careful considerations must be made if these areas cover roads or properties, as some standing water or ponding can be expected. For these, increased water redirection such as ditches to allow water to continue down away from critical areas would be beneficial as they can act as temporary storage.

If many large red areas flow into each other or towards a green area, it could cause the green areas to eventually overflow as well. The main area of concern is the north-east and west borders of town, along the roads. Increasing the road height of these areas could prove beneficial for halting and redirecting flood water south of town towards natural storage basins.

Overall, development should maintain or enhance infiltration and storage capacity, especially for green areas and increase water diversion to reduce overflow through town. Incorporating low impact development, such as permeable pavement, rain gardens, and green roofs, could significantly reduce surface runoff by lowering the C value, and increase infiltration capacity.

2.4.4 Limitations

There were limitations due to data availability and technology requirements. Below is a summary.

- Available elevation files for the area are from 2009
- There may be data quality issues that could not be mediated
- Breaching calculations (to increase elevation data quality) were not possible due to large processing power requirements
- A larger scale would give a more accurate accumulation value, however this would take much more computing power
- The Surface cover map used has a 30 m resolution, while the elevation resolution is 2 m
 - This generalizes runoff coefficient, especially within the town
- Model assumes upstream maximum C is the same as the receiving polygon
 - Can result in an over or under estimation of incoming volume

For the areas in town, it is more likely an overestimation, due to the high C value of paved areas, which is assumed to be most of the area.

This analysis has been prepared for planning and informational purposes only and does not constitute engineering advice. The results are intended to support high-level municipal flood risk and climate adaptation assessments and are not suitable for detailed engineering design or construction without review and application by a licensed professional engineer.

3. COMMUNITY ENGAGEMENT

Community engagement formed a central pillar of the Climate Adaptation Plan, ensuring that local knowledge, lived experience, and public priorities informed decision-making. The primary engagement tool was the “*Community Perspectives: Climate Risks*” survey, which provided both quantitative and qualitative insight into how residents perceive climate-related risks and what they value most in terms of protection and investment.

3.1 Overview of the Engagement Process

3.1.1 Objectives

Engagement activities were undertaken to support the development of the Town of Altona’s Climate Change Adaptation Plan by integrating both community perspectives and local operational expertise. The engagement process was designed to:

- Understand residents’ lived experience with climate-related events and identify priority concerns within the community
- Confirm locally relevant climate hazards and how they are affecting Altona today
- Identify key municipal systems and services most exposed to climate impacts
- Build shared understanding of climate risks and strengthen internal alignment on priority adaptation needs
- Generate practical input to inform risk prioritization and future adaptation actions

3.1.2 Engagement Approach

Engagement was delivered through two complementary activities: a community survey and a facilitated risk assessment workshop.

A community survey was developed to gather input directly from residents on their climate-related concerns and experiences. The survey questions were prepared based on expected climate hazards that may affect Altona, with the goal of understanding:

- which hazards residents are most concerned about,
- what impacts people are already noticing, and
- where residents see the greatest vulnerabilities.

The Town of Altona’s Manager of Community Services led the implementation of the survey, which was created digitally and promoted through social media, paid advertising on a local digital media platform, and the Town of Altona website. To support broader accessibility and reach residents who may not participate through online channels, the Town also set up a physical survey display at the Altona Community Meal, which regularly welcomes approximately 200 community members for a free meal and connection.

In addition to the survey, a Risk Assessment Workshop (see Section 3.3.2. Risk Assessment Workshop) was held with Town staff and stakeholders to apply local knowledge and operational experience to the identification and prioritization of climate risks. The workshop focused on the climate hazards identified through the climate context review and community input and supported structured discussion of potential impacts across municipal infrastructure, essential services, and community well-being. The workshop also enabled participants to assess risks using a consistent scoring approach, building a shared understanding of which risks require the most immediate and strategic attention through adaptation planning.

Together, these engagement activities provided both community-informed insight and municipal operational perspective to inform the climate risk priorities and adaptation directions presented in this Plan.

3.2 Community Survey Summary

3.2.1 Purpose of the Survey

The purpose of the community survey was to ground the Climate Adaptation Plan in the realities of everyday life in Altona and to ensure that proposed actions reflect community concerns rather than solely technical or model-based assessments. Specifically, the survey aimed to:

- Assess public awareness and perceptions of climate risks, including the relative importance residents assign to different hazards such as flooding, extreme heat, winter storms, and high winds
- Identify community priorities, particularly which services, infrastructure systems, and aspects of daily life residents are most concerned about protecting from extreme weather
- Capture qualitative insights into perceived vulnerabilities among different population groups, including seniors, outdoor workers, and households with limited resources
- Support legitimacy and public trust, by demonstrating that the adaptation plan is informed by direct community input rather than top-down assumptions

A total of 53 residents participated in the survey, providing a meaningful snapshot of local sentiment and priorities that complement technical risk assessments. Although seniors and low-income households were underrepresented, respondents consistently voiced worry for those without air conditioning or mobility during heatwaves and power outages. In addition, the selection of stakeholders involved in the workshops described in Section 3.3 was targeted, to include all perspectives despite the barrier to survey participation.

3.2.2 Key Themes and Findings

Survey responses revealed a clear hierarchy of concerns, as well as important nuances in how residents interpret climate risk.

3.2.2.1 *Primary Hazards of Concern*

Across nearly all sectors, heavy rainfall and flooding emerged as the dominant concern. Respondents consistently ranked flooding as the greatest threat to essential services, homes, transportation, and economic stability. Winter hazards such as blizzards and ice storms were also rated highly, reflecting Altona's experience with severe winter weather and its impact on mobility and service delivery.

3.2.2.2 *Critical Services as Top Priorities*

Residents expressed the strongest concern for the resilience of healthcare and social supports, power and electricity systems, and water and wastewater services. These "lifeline systems" were viewed as essential to community safety during extreme weather events, with disruptions seen as having immediate and severe consequences.

3.2.2.3 *Infrastructure and Economic Stability*

Concerns extended beyond physical damage to include household finances, employment stability, and the ability to travel safely. Many respondents highlighted the indirect economic impacts of extreme weather, such as lost workdays, repair costs, and service interruptions.

3.2.2.4 *Heat and Drought Perceptions*

While extreme heat and drought were identified as risks, they were generally ranked lower than flooding and winter storms. This suggests a potential perception gap between current public concern and climate projections, which indicate a significant increase in heat-related risk over coming decades.

Note: heat extremes are more likely to result in illness or death than the other climate extremes.

3.2.2.5 Qualitative Insights

Open-ended responses added depth to the quantitative findings. Comments revealed:

- Strong concern for vulnerable populations, particularly seniors and individuals without access to air conditioning
- Calls for practical, visible improvements to core municipal services, such as stormwater management and snow clearing
- A range of perspectives on climate change itself, from proactive concern to skepticism, highlighting the need for careful and inclusive communication

Together, these themes indicate that while opinions differ, residents broadly agree on the importance of protecting the well-being of the community, including essential services, infrastructure reliability, and economic security.

3.2.3 How Community Input Informed the Plan's Priorities

The results of the community survey directly shaped the focus and structure of the Climate Adaptation Plan.

First, the strong emphasis on flooding and water-related risks reinforced the need to prioritize stormwater management, drainage capacity, and water infrastructure resilience as core adaptation actions. These priorities align closely with existing technical assessments, strengthening confidence in their importance.

Second, high levels of concern for power, healthcare, and municipal services informed the plan's emphasis on protecting critical infrastructure and maintaining service continuity during extreme events. Adaptation measures were therefore framed around reliability, redundancy, and emergency preparedness rather than abstract climate targets.

Third, awareness of economic and household impacts encouraged a focus on cost-effective, targeted actions that deliver clear community benefits. This includes prioritizing measures that reduce long-term maintenance costs, avoid future damage, and protect residents' livelihoods.

Finally, the diversity of viewpoints expressed in the survey underscored the importance of clear, non-polarizing communication. As a result, the plan emphasizes shared values such as safety, fiscal responsibility, and protection of community assets rather than ideological framing.

In summary, the community survey served as a critical evidence base that ensured the Climate Adaptation Plan is locally grounded, socially informed, and aligned with the issues residents care about most.

3.3 Workshops Conducted

Community workshops were a cornerstone of the engagement process, serving to collaboratively define Altona's climate vision, identify key values, and rigorously assess and prioritize climate risks. Two targeted workshops were held on October 2nd and 3rd, 2025, bringing together municipal staff, council members, and key community stakeholders.

3.3.1 Vision and Priorities Workshop

The first workshop focused on developing a shared vision for a climate-resilient Altona and identifying community priorities. Participants emphasized that Altona's resilience depends on reliable, well-maintained infrastructure and inclusive community services that protect all residents during climate events.

Key themes emerging from the discussions included:

- **Infrastructure resilience:** Upgrading and maintaining stormwater, sanitary sewer, and road systems to handle increasingly frequent heavy rainfall and snowmelt events, including the need to address lift station capacity issues.

- **Flood and storm management:** Continued investment in flood mitigation and stormwater diversion projects, informed by the recent infiltration study and overland flow mapping.
- **Water security:** Strengthening redundancy in water treatment and intake systems to ensure reliable supply during drought and extreme-heat conditions, including potential improvements to membrane filtration.
- **Community Well-Being and vulnerable populations:** Preparing for extreme heat, poor air quality from wildfire smoke, and power outages by improving public awareness, access to emergency services, and availability of cooling and clean air spaces.
- **Natural assets and green spaces:** Expanding the urban forest canopy and maintaining green infrastructure to manage runoff, provide shade, and enhance community livability.
- **Governance and preparedness:** Strengthening emergency management, expanding warning systems and communication networks, and building staff capacity to respond effectively to climate-related events.

Participants also discussed barriers such as limited budgets, staff capacity, interjurisdictional challenges, and aging infrastructure. Opportunities were identified in community partnerships, education and training programs, and leveraging existing planning initiatives (e.g., stormwater management and asset management plans).

3.3.2 Risk Assessment Workshop

The second workshop built on the first session's priorities by evaluating specific climate risks and vulnerabilities across Altona's systems, infrastructure, and community sectors. Participants worked collaboratively to evaluate the severity of four primary climate hazards: Drought and Extreme Heat, Flooding, Gusty Winds and Tornadoes, and Air Quality.

Key themes and discussion points included:

- **Drought and Extreme Heat:** Longer dry periods and higher temperatures stress both municipal water supplies and agricultural productivity, prompting discussion on water-use prioritization for essential needs such as community gardens and crop irrigation.
- **Flooding:** Heavy rainfall events are overloading existing systems. While infiltration remains acceptable under normal conditions, extreme events (e.g., spring 2022) cause lift-station overloads, sewer back-ups and surface flooding.
- **Gust Winds and Tornadoes:** Participants noted that high-wind damage and debris hazards could disrupt power and transportation networks, highlighting the need for emergency-shelter planning and communication readiness.
- **Air Quality:** Wildfire smoke has become a recurring seasonal issue, affecting community well-being, outdoor activities, and vulnerable populations, emphasizing the need for public education, preparedness planning, clean-air shelters and filtration systems.

Concerns were also raised about aging underground infrastructure, which is vital for services like stormwater and wastewater management yet often unseen, requiring proactive maintenance and upgrades to prevent failure during extreme weather. Participants consistently highlighted the need for enhanced winter preparedness, pointing to gaps in public education regarding safe driving and vehicle maintenance in extreme cold, as well as the vulnerability of populations lacking proper winter clothing. The workshop emphasized the importance of ongoing investment in water and wastewater infrastructure, education and outreach, and planning for vulnerable populations.

3.3.3 Summary of Outcomes

Collectively, participants expressed a strong desire for proactive leadership and coordination, ensuring Altona remains a safe, sustainable, and connected community in the face of evolving climate challenges. Participants recognized that planning ahead is more cost-effective than reacting to damage and disruption.

The outcomes from these workshops directly informed the development of the Climate Risk and Vulnerability Assessment (Section 4), the Adaptation Goals and Strategic Directions (Section 5), and the Adaptation Actions (Section 6) of this Plan. A detailed discussion is included in Appendix A.

4. CLIMATE RISK AND VULNERABILITY ASSESSMENT

4.1 Methodology and Scoring Approach

The Climate Risk and Vulnerability Assessment used a semi-quantitative scoring approach to rank climate risks based on **likelihood** and **severity/consequence**. Risks were evaluated through a combination of technical analysis, staff input, and stakeholder workshops. More details can be found on Appendix A.2.

Each identified hazard was assessed against the following criteria:

- **Likelihood:** Expected frequency and probability of occurrence of a given climate hazard under current and future climate conditions
- **Severity/consequence:** Potential impacts of the climate hazard on public safety, service delivery, infrastructure, environment, and the local economy

Scores were assigned using a five-point scale and combined to produce an overall risk rating (Low, Moderate, High, Very High). Workshop participants validated and refined scores based on operational experience and local knowledge.

4.2 Risk Ranking Matrix

The graph below shows the risk ranking matrix used to identify the risks from climate hazards based on the combination of likelihood and severity:

Consequences	Very High	Moderate Risk	High Risk	High Risk	Extreme Risk	Extreme Risk
	High	Low Risk	Moderate Risk	High Risk	High Risk	Extreme Risk
	Moderate	Low Risk	Low Risk	Moderate Risk	High Risk	High Risk
	Low		Low Risk	Low Risk	Moderate Risk	Moderate Risk
	Very Low			Low Risk	Low Risk	Low Risk
		Very Low	Low	Moderate	High	Very High
Likelihood						
Extreme Risk (Red): Immediate controls required High Risk (Orange): High priority control measures required Moderate Risk (Yellow): Some controls required to reduce risks to lower levels Low Risk (Blue): Controls likely not required Negligible Risk (Green): Risk events do not require further consideration						

Figure 4: Risk Rating

4.3 Summary of Identified Risks

This summary integrates the flood and drainage analysis (Section 2.4), local setting (Section 2.3), survey/workshops (Section 3), and the sector-specific vulnerabilities/actions identified.

4.3.1 Primary Hazards

The main climate hazards identified are listed below:

- **Flooding / Extreme Rainfall (short duration):** In several neighborhoods and along specific flow paths, short storms produce rapid ponding and overland movement that exceed localized storage and conveyance capacity. Historical observations indicate that approximately 20–25 homes experience recurrent basement flooding, with risks concentrated where local depressions, road profiles, and system bottlenecks coincide. An infiltration study conducted in September 2025 showed that infiltration of the sanitary network through joints and manholes was far below that of other urban centres across Canada. The surcharges observed during intense events are primarily attributed to outdated building standards (residential drainage tile systems and sump pumps “plumbed into” the sanitary system).
- **Drought & Extreme Heat:** Emerging risks to water security and community well-being. Higher temperatures, longer dry spells, and peak day demand place pressure on treatment, storage, and distribution. Residents without access to effective cooling or clean indoor air are particularly vulnerable during multi day heat waves or smoke episodes.
- **Winter Storms (blizzard/ice):** Mobility disruption, power/communications outages; cold-exposure risks; vehicles/equipment vulnerabilities.
- **Gusty Winds & Tornadoes:** Outages and damage to overhead power lines; debris hazards; risks to roofs and outdoor facilities.
- **Air Quality (wildfire smoke):** Regional wildfire smoke has become more common, driving seasonal restrictions on outdoor activity and underscoring the need for clean air spaces.

4.3.2 Systems & Sectors Most Exposed

The following systems and sectors are considered the most exposed to the climate hazards identified (see Appendix E to identify the adaptation actions for each system and sector):

- **Stormwater network:** Inlet/culvert blockages, limited capacity, debris accumulation after floods (Actions #52–58).
- **Sanitary networks:** experiences infiltration through aging joints and manholes, and occasional surcharge during intense events.; need for surge storage and sealing (Actions #1–6).
- **Roads & transportation:** Low-lying access routes; gravel/asphalt degradation; need for elevation and resilient materials (Actions #101–106).
- **Water supply & management:** Dependence on external sources; drought protocols, storage, leak detection, reuse, regional agreements (Actions #7–9, 11).
- **Health care & social supports:** Surge in demand during floods/heat; continuity of power, water, and communications; mobile/remote service capacity (Actions #25,27,29-33,35–39).
- **Local economy sectors (construction, food services, accommodation, recreation, waste):** Scheduling, storage, safety protocols, efficiency retrofits, and contingency planning (selected actions throughout #13–70, #83–112).

4.3.3 Cross-cutting Vulnerabilities

- **Flat terrain + clayey soils** → low infiltration, high ponding.
- **Aging underground infrastructure** with long renewal cycles.
- **Operational capacity constraints** (staff, budgets) after events.
- **Risk communication needs:** community responds best to practical, **hazard-focused** messaging (safety, service reliability, cost avoidance).

4.4 Key Takeaways

The main takeaways from the analysis are summarized below:

- **Flood resilience is the top priority.** Target sanitary inflow and infiltration (I/I), storm drain capacity and maintenance, local storage basins, and road profile/elevation at flood-path pinch points.
- **Protect lifeline services.** Guarantee power, water, wastewater, communications, and healthcare continuity with redundancy, emergency protocols, and mutual aid.
- **Prepare for hotter, drier summers while keeping winter readiness strong.** Cooling/clean-air centers, drought tiering, leak detection, and conservation programs are immediate wins.
- **Pair engineering with nature-based solutions.** Bioswales, rain gardens, wetlands, and urban canopy improve runoff management, shade, and overall livability.
- **Use practical, inclusive communication.** Emphasize hazard preparedness, safety, **service reliability**, and **value for money**, avoiding polarizing terminology.
- **Embed adaptation into governance.** Integrate climate into asset management, development standards, procurement, capital planning, and performance reporting.

5. ADAPTATION GOALS AND STRATEGIC DIRECTIONS

5.1 Overall Adaptation Goal

Keep Altona safe, connected, and thriving by protecting essential services and infrastructure from flood, storm, heat, drought, wind, and smoke—using practical, cost-effective measures that reflect local values and deliver visible benefits.

5.2 Guiding Principles

Altona's adaptation program rests on the eight guiding principles listed below:

- **Safety & Health First:** Prioritize actions that reduce risks to residents—especially seniors, children, outdoor workers, and households lacking resources.
- **Service Continuity:** Maintain reliability of lifeline systems (power, water, wastewater, communications, healthcare) during and after events.
- **Evidence-Informed & Locally Grounded:** Combine technical analysis with lived experience and local knowledge.
- **Value for Money:** Focus on high-impact, cost-effective measures with O&M savings and avoided damages.
- **Nature + Engineering:** Integrate green infrastructure with upgrades to pipes, pumps, and roads.
- **Equity & Accessibility:** Ensure inclusive access to cooling, clean-air, and warming supports.
- **Integration & Accountability:** Apply a climate lens across planning, asset management, procurement, and transparent reporting.
- **Adaptive Capacity:** Strengthen the Town's ability to anticipate, respond to, and learn from climate-related impacts over time. This includes enhancing internal coordination, improving monitoring and data use, supporting staff and Council learning, and embedding continuous improvement practices.

5.3 Strategic Directions (priorities)

The overall Adaptation Goal and Guiding Principles lead to 5 focused Strategic Directions (Priorities). These directions are the high-level themes that structure the action plan (Section 6), ensuring that resources and efforts are concentrated on the most critical and impactful areas identified through the technical assessments and the community engagement process. These directions will provide a framework for decision-making, investment, and monitoring.

The 5 Strategic Directions for the Town of Altona are:

Strategic Direction 1: Protect Community Well-Being and Support Vulnerable Populations

Reduce climate-related health risks associated with heat, air-quality degradation, and extreme events, and improve preparedness for all residents, especially those most at risk.

Focus: Protecting the public from both acute (e.g., flood events) and chronic (e.g., rising heat) climate hazards. This includes enhancing the Town's emergency preparedness protocols, developing strategies for managing extreme heat events, and ensuring the continuity of essential municipal services during and after a climate impact.

Basis: The anticipated increase in extreme weather (Section 2.2) and the risks identified regarding community well-being impacts, emergency response capacity, and the protection of vulnerable populations during extreme weather.

Strategic Direction 2: Build Governance, Capacity, and Collaboration

Embed climate adaptation into municipal governance, planning, and community culture, fostering coordinated resilience efforts.

Focus: Shifting municipal operations to proactively embed climate considerations into long-term decision-making. This involves integrating the Climate Lens into key processes such as the Asset Management Plan, Development Planning, and Procurement Policies. This direction ensures the Adaptation Plan is not a standalone document but a central driver of sustainable growth.

Basis: The necessity for a systemic approach to sustain resilience gains. This direction ensures ongoing financial and operational capacity to pursue the actions in Section 6.

Strategic Direction 3: Strengthen Flood and Stormwater Resilience

Enhance the capacity and reliability of Altona's stormwater and sewer systems to manage heavy rainfall and spring melt events.

Focus: Addressing Altona's primary climate vulnerability: the capacity of its stormwater, drainage, and sanitary sewer systems to manage extreme precipitation events and overland flow. This direction prioritizes infrastructure upgrades, the integration of nature-based solutions (NBS) (such as enhanced wetlands and bioswales), and improved land-use planning to manage runoff.

Basis: The findings from the Flood and Drainage Analysis (Section 2.4) and the consistent prioritization of flooding/drainage issues across the Community Survey (Section 3.2) and the Risk Assessment Workshop. The need to provide relief and capacity to the sanitary sewer system, as suggested by the infiltration study, falls under this direction.

Strategic Direction 4: Ensure Long-Term Water Security

Safeguard Altona's water supply, treatment, and distribution systems amid rising temperatures and prolonged dry periods.

Focus: Enhancing the resilience and reliability of Altona's water systems to ensure a secure supply under conditions of drought, extreme heat, or water-quality threats. This includes expanding redundancy within

the treatment and intake systems, promoting conservation practices, and establishing clear drought-management protocols to prioritize essential water uses.

Basis: Findings from the Risk Assessment Workshop identified drought and extreme heat as key hazards affecting both municipal water systems and agricultural productivity. Community input also emphasized the need for redundancy and proactive management to safeguard supply during prolonged dry periods.

Strategic Direction 5: Enhance Natural Assets and Green Infrastructure

Leverage natural systems to complement built infrastructure and improve resilience.

Focus: Integrating the management of natural assets such as trees, green spaces, wetlands, and drainage corridors, into municipal planning and infrastructure strategies. By valuing and maintaining these assets, Altona can mitigate flood and heat risks, improve stormwater management, and enhance quality of life for residents.

Basis: Community and workshop discussions highlighted the importance of urban forest management and preserving natural areas. This direction supports a balanced approach between engineered and nature-based resilience.

6. ADAPTATION ACTIONS AND IMPLEMENTATION PLAN

6.1 Overview of Action Development

Actions were developed through the stepwise, structured process described below:

Step 1 — Consolidation of local evidence and priorities:

- GIS-based drainage analysis (Section 2.4), local terrain/soils (Section 2.3).
- Community survey and workshops (Section 3) emphasizing lifeline services and flood hazards.
- Identification of sector vulnerabilities.

Step 2 — Development of list of options and screening:

- Development of a list of adaptation measures across engineering, nature-based solutions, Operations & Maintenance, community well-being, governance, and economic resilience.
- Screened for feasibility (cost, complexity, jurisdiction), impact (risk reduction), co-benefits (health, O&M), and alignment with strategic directions.

Step 3 — Prioritization & Packaging:

- Timelines: Screened action were classified according to their desirable timelines such as Near (0–2 yrs), Medium (3–5 yrs), Long (5+ yrs).
- Leads & partners: Assigned by department and regional collaborators.
- Funding pathways: Identified potential sources of funding such as Infrastructure Canada's Disaster Mitigation and Adaptation Fund (DMAF), the Federation of Canadian Municipalities' Green Municipal Fund (GMF), Manitoba Water Services Board, Manitoba Municipal Relations programs, Manitoba Hydro partnerships, regional health authorities, Pembina Valley Water Co-op; plus philanthropic/utility contributions where applicable.
- Monitoring & reporting: Monitoring and reporting indicators were developed to track the implementation and effectiveness of the adaptation actions. These indicators can be found in Section 7.4.

6.2 Action Tables by Strategic Direction

This section presents detailed adaptation actions organized under Altona's five Strategic Directions. Actions were selected based on the Flood & Drainage analysis (Section 2.4), community survey/workshops (Section 3), and sector-specific measures reviewed with Town administration. Altona's feedback has been integrated to emphasize practical, visible measures, hazard-focused language (floods, heat, smoke, blizzards, gust winds), and operational realism. Each table includes action descriptions, lead departments/partners, timelines, priority levels, potential funding sources, and notes reflecting Altona's comments.

Note: costs were estimated.... Or costs are just an order of magnitude preliminary estimate or something

6.2.1 Cost Legend (planning-level order of magnitude)

\$ ≈ up to \$25k;

\$ \$ ≈ \$25k–\$150k;

\$ \$ \$ ≈ \$150k–\$1M;

\$ \$ \$ \$ ≈ > \$1M

6.2.2 Strategic Direction 1 — Protect Community Well-Being and Support Vulnerable Populations

Table 1. Adaptation actions for Strategic Direction 1 — Protect Community Well-Being and Support Vulnerable Populations

Action ID	Action Description	Lead / Partners	Timeline	Priority	Potential Funding	Consulting Fees (CAD)	Implementation Costs (CAD)
33 ¹	Cooling & hydration spaces: designate/equip public buildings (A/C, shade, water stations) as Cooling/Clean-Air Centres during heat/smoke advisories.	Community Services; Southern Health; Rhineland CARE; Emergency Response Group (ERG)	Short (0–2 yrs)	High	FCM GMF; MB Municipal Relations; Public Health funds	\$	\$\$
35	Heat-health early warning & response protocol (triggers, scripts, outreach) with Southern Health.	ERG; Southern Health; Rhineland CARE; Communications	Short	High	MB Municipal Relations; Public Safety programs	\$	\$
36	Wellness checks for vulnerable residents (calls/visits during heat waves).	Social Services; NGOs; Rhineland CARE; ERG	Short	High	Local grants; Health region support	\$	\$
29	Opt-in vulnerable population registry (evacuation/medical assistance).	ERG; Social Services; Rhineland CARE	Short	High	MB Municipal Relations; Public Safety programs	\$	\$
27	Mobile/remote care capacity (telehealth, mobile clinics during access disruptions).	Southern Health; ERG; Rhineland CARE	Medium (3–5 yrs)	Medium	Health-system funds; philanthropic	\$\$	\$\$
37	Public messaging on heat safety & water conservation (town channels & social media).	Communications; ERG; PVWC; Rhineland CARE	Short	Medium	FCM GMF (education); PVWC	\$	\$
113	Council & staff training on hazard literacy, emergency playbooks, and climate lens in procurement/asset management.	CAO; ERG; Finance/Procurement	Short	Medium	MB Municipal Relations; FCM Asset Management	\$	\$

¹ Public buildings already have air conditioning, additional shaded areas and water stations could be developed within existing budgets.

6.2.3 Strategic Direction 2 — Build Governance, Capacity, and Collaboration

Table 2. Adaptation actions for Strategic Direction 2 — Build Governance, Capacity, and Collaboration

Action ID	Action Description	Lead / Partners	Timeline	Priority	Potential Funding	Consulting Fees (CAD)	Implementation Costs (CAD)
4	Sanitary I/I monitoring program (CCTV, smoke testing, metering) with schedules & SOPs.	Public Works (PW)(Sanitary)	Short	High	MB Water Services Board; DMAF (planning)	\$\$	\$\$
5	Private-property inflow reduction: disconnect sump/roof drains; bylaw/incentives & outreach.	PW; Planning; Communications	Short	High	MB Municipal Relations; FCM GMF (community programs)	\$	\$
6	Hazard-aware land-use & site-level stormwater standards (NBS, permeable surfaces, flood-aware development).	Planning & Development	Medium	High	FCM GMF; DMAF (design)	\$\$	\$\$
55	GIS asset inventory & maintenance mapping for stormwater (cleaning cycles, priorities).	PW; GIS	Short	Medium	FCM Asset Management; MB Municipal Relations	\$	\$\$
58	Stormwater Master Plan update (capacity, projections, upgrade roadmap).	PW (Storm); Planning	Medium	High	DMAF; MB Water Services Board	\$\$	\$\$\$

6.2.4 Strategic Direction 3 — Strengthen Flood and Stormwater Resilience

Table 3. Adaptation actions for Strategic Direction 3 — Strengthen Flood and Stormwater Resilience

Action ID	Action Description	Lead / Partners	Timeline	Priority	Potential Funding	Consulting Fees (CAD)	Implementation Costs (CAD)
1 ²	Seal manholes/pipes (chemical grouting, CIPP, gasketed covers) in leak-prone basins.	PW (Sanitary); Contractors	Short	High	MB Water Services Board; DMAF (rehab)	\$\$	\$\$\$
2	Backflow prevention devices in older properties & nodes; awareness program.	PW; Building/Bylaw; Homeowners	Short	High	MB Municipal Relations (incentives)	\$	\$\$
3	Evaluate surge storage feasibility (equalization basins/oversized interceptors).	PW; Engineering consultant	Medium	Medium	DMAF (design); MB Water Services Board	\$\$	\$\$\$
52	Storm drain upgrades & annual inspections (inlets, culverts).	PW (Storm)	Short	High	MB Water Services Board; DMAF (small works)	\$	\$\$
53	Post-flood debris clearing SOP for surface drains/culverts (formalize and resource).	PW (Storm)	Short	High	Operating; MB Municipal Relations (capacity)	\$	\$
54	Nature-based runoff management (bioswales, rain gardens, permeable surfaces) at red-zone depressions; protect green sinks.	PW; Planning; Watershed District	Medium	High	FCM GMF; EcoAction; DMAF (NBS)	\$\$	\$\$\$
101	Roadside drainage & culvert capacity upgrades (ditch profiles, culvert sizing).	PW (Roads)	Short–Medium	High	MB Water Services Board; DMAF; Provincial roads funds	\$\$	\$\$\$
103	Raise critical routes where ponding/flow paths cross.	PW (Roads)	Short–Medium	High	DMAF; Provincial programs	\$\$	\$\$\$

² The Town recently received preliminary analysis of infiltration into their sanitary sewer network and scored very well against the industry average. They have also finished a full televised inspection of their sanitary sewer mains and will be reviewing this to identify problem areas to address.

Action ID	Action Description	Lead / Partners	Timeline	Priority	Potential Funding	Consulting Fees (CAD)	Implementation Costs (CAD)
95	Home floodproofing: incentives for sump pumps & sewer backflow preventers; focus on 20–25 frequently affected homes.	Utilities; PW; Communications	Short	High	MB Municipal Relations; Utility rebates; FCM GMF	\$	\$\$
98/99	Resident guidance & rapid cleanup plans post-flood (checklists, inspections, safe re-entry).	ERG; Communications; PW	Short	Medium	MB Municipal Relations	\$	\$

6.2.5 Strategic Direction 4 — Ensure Long-Term Water Security

Table 4. Adaptation Actions for Strategic Direction 4 — Ensure Long-Term Water Security

Action ID	Action Description	Lead / Partners	Timeline	Priority	Potential Funding	Consulting Fees (CAD)	Implementation Costs (CAD)
7	Increase local storage capacity (reservoir/elevated tank) with turnover & fire-reserve analysis.	Utilities (Water); Engineering	Medium	High	MB Water Services Board; DMAF (design/build)	\$\$	\$\$\$\$
8	Active leak detection & pressure management (smart meters/controls).	Utilities	Medium	Medium	FCM GMF; Operating; MB Water Services Board	\$\$	\$\$\$
9	Non-potable reuse for municipal & industrial uses (irrigation, cooling, dust suppression).	Utilities; PW; Industry	Medium	Medium	FCM GMF; EcoAction; Industry co-funding	\$\$	\$\$
11	Public & industrial efficiency programs (rebates, audits, xeriscaping).	Utilities; PVWC; Chamber	Short–Medium	Medium	FCM GMF; PVWC; Efficiency Manitoba	\$	\$\$

6.2.6 Strategic Direction 5 — Enhance Natural Assets and Green Infrastructure

Table 5. Adaptation actions for Strategic Direction 5 — Enhance Natural Assets and Green Infrastructure

Action ID	Action Description	Lead / Partners	Timeline	Priority	Potential Funding	Consulting Fees (CAD)	Implementation Costs (CAD)
54	Bioswales & rain gardens at runoff pinch points; permeable pavement pilots; protect high-capacity green sinks.	Planning; PW; Watershed District	Medium	High	FCM GMF; EcoAction; DMAF (NBS)	\$\$	\$\$\$
84/114	Urban Canopy Strategy to Shade Streets/Schools & Heat-Risk Blocks First; Integrate with Active Transportation (AT) Routes	Planning; schools; AT partners	Medium	Medium	FCM GMF; MB Municipal Relations	\$	\$\$
61	Shade structures & reflective surfaces at recreation sites to reduce heat gain.	Recreation	Short–Medium	Medium	FCM GMF; Efficiency Manitoba	\$	\$\$

6.2.7 Cross-sector Actions (supporting multiple directions)

Table 6. Other a\Adaptation Cross-sector Actions

Action ID	Action Description	Lead / Partners	Timeline	Priority	Potential Funding	Consulting Fees (CAD)	Implementation Costs (CAD)
40/41/42	Efficiency retrofits in accommodation & homes: cooling upgrades, low-flow fixtures, high-efficiency appliances (deliver messaging via Chamber & PVWC).	Chamber; Efficiency Manitoba; Utilities	Medium	Medium	Efficiency Manitoba; FCM GMF	\$	\$\$
43/50/51	Common drought messaging for food services & public (conservation guidelines; local sourcing partnerships).	Communications; Chamber; PVWC	Short	Medium	FCM GMF; PVWC	\$	\$
83/86/87/88	Affordable mobility & shaded routes: car-share pilot, mobility support in heat events, active transport promotion.	Community partners; Planning; ERG	Medium	Medium	MB Municipal Relations; FCM GMF	\$	\$\$
92/93/94	Worker heat safety & waste-site risk reduction: training, shifted collection schedules, battery disposal campaigns.	Safety Coordinator; Waste contractor; Communications	Short	Medium	MB Municipal Relations; Operating	\$	\$
108	Targeted undergrounding of overhead lines in high-risk corridors for gust winds/tornadoes (apply by default in new developments).	Manitoba Hydro; Planning	Long	Medium	Hydro partnerships; DMAF (resilience)	\$\$	\$\$\$\$

7. IMPLEMENTATION AND MONITORING FRAMEWORK

This section explains how the Town of Altona will implement the Climate Change Adaptation Plan, track its progress, and make improvements over time. The plan takes into account the Town's resources and aims to fit with current planning and budgeting cycles. It uses a step-by-step approach, starting with high-impact, practical actions now and planning for bigger, more complex projects later. This framework is designed not only to advance priority adaptation actions but also to strengthen the Town's organizational adaptive capacity by embedding monitoring, learning, and climate-informed decision-making into existing municipal processes.

7.1 Implementation Approach

This Climate Change Adaptation Plan is designed to be practical and fit within the Town of Altona's current operations and processes. It does not create a separate program or add major new administrative tasks. Instead, the actions will move forward through existing workflows like annual budgeting, capital planning, routine maintenance, asset management, and emergency preparedness.

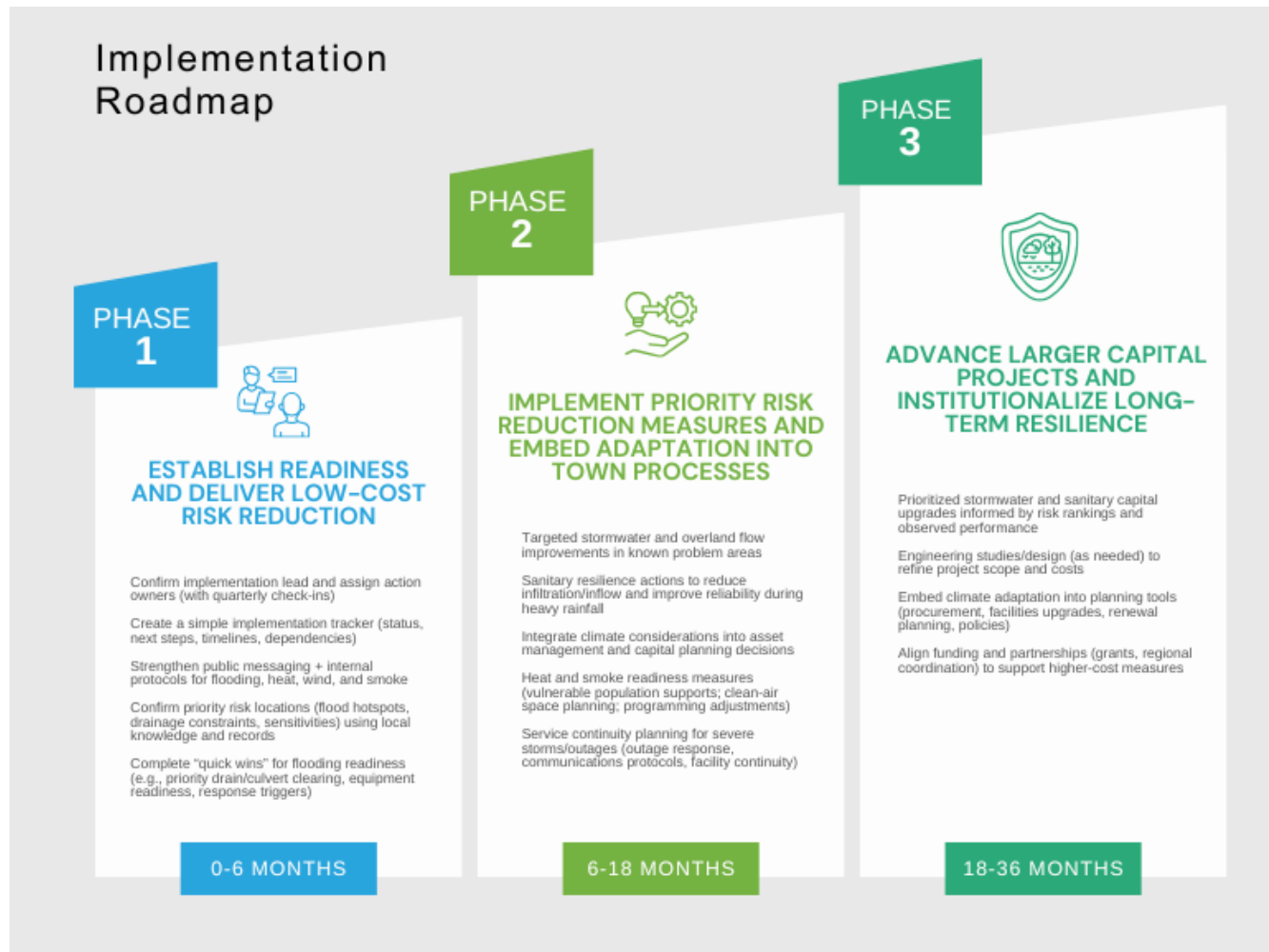
This plan uses a phased approach to make delivery more realistic. It starts with near-term actions that are low-cost, practical, and quickly reduce risks. Bigger and more technical projects are scheduled for later to align with planning, design, procurement, and funding timelines and opportunities. This way, the plan can move forward steadily and stay flexible to adapt to new needs or opportunities.

Each priority action should have one lead department and clear supporting roles. Progress reviews should be short, focused on decisions, and fit into regular management meetings. Monitoring and reporting should be practical and use existing data sources whenever possible, such as maintenance records, incident logs, and capital project documents.

7.2 Implementation Roadmap

The Implementation Roadmap below organizes adaptation actions into three phases over 36 months to support practical implementation and resourcing. The phases reflect risk urgency, feasibility, and alignment with Town planning and budgeting processes:

Table 7. Implementation Roadmap



Phase	Timeframe	Primary Objective	Priority Actions (summary)	Typical Lead(s)	Resourcing Note
1	0–6 months	Establish readiness and deliver low-cost risk reduction	<p>Confirm implementation lead and assign action owners (with quarterly check-ins)</p> <p>Create a simple implementation tracker (status, next steps, timelines, dependencies)</p> <p>Strengthen public messaging + internal protocols for flooding, heat, wind, and smoke</p> <p>Confirm priority risk locations (flood hotspots, drainage constraints, sensitivities) using local knowledge and records</p> <p>Complete “quick wins” for flooding readiness (e.g., priority drain/culvert clearing, equipment readiness, response triggers)</p>	Public Works / Utilities; Administration; Community Services; Emergency Management (as applicable)	Primarily in-house, low-cost; focused on coordination, maintenance, and communications
2	6–18 months	Implement priority risk reduction measures and embed adaptation into Town processes	<p>Targeted stormwater and overland flow improvements in known problem areas</p> <p>Sanitary resilience actions to reduce infiltration/inflow and improve reliability during heavy rainfall</p> <p>Integrate climate considerations into asset management and capital planning decisions</p> <p>Heat and smoke readiness measures (vulnerable population supports; clean-air space planning; programming adjustments)</p> <p>Service continuity planning for severe storms/outages (outage response, communications protocols, facility continuity)</p>	Public Works / Utilities; Administration; Community Services; Emergency Management; external technical support (as needed)	Mix of in-house + targeted external support; some actions may require minor capital funding
3	18–36 months	Advance larger capital projects and institutionalize long-term resilience	<p>Prioritized stormwater and sanitary capital upgrades informed by risk rankings and observed performance</p> <p>Engineering studies/design (as needed) to refine project scope and costs</p> <p>Embed climate adaptation into planning tools (procurement, facilities upgrades, renewal planning, policies)</p> <p>Align funding and partnerships (grants, regional coordination) to support higher-cost measures</p>	Administration; Public Works / Utilities; Council (budget approval); external engineering support	Higher reliance on capital planning and external expertise; grant alignment recommended

7.3 Governance and Roles

The implementation of the adaptation measures described in this report requires a framework of governance and specific roles, which are defined below:

- **Council:** Set policy; approve budgets; champion integration of climate lens; receive annual reports.
- **CAO & Senior Management:** Own implementation; align departmental work plans; convene **Adaptation Working Group**.

Planning & Development involves updating engineering standards, embedding NBs and site-level storage/infiltration in project development, setting canopy targets, and remaining aware of the flood hazards when make road/land use decisions. The supporting roles include:

- **Public Works (Stormwater/Sanitary/Roads):** Deliver upgrades; O&M programs; post-event assessments; asset data collection.
- **Utilities (Water):** Drought tiering; storage expansion; leak detection; regional coordination; efficiency programs.
- **Community Services/Facilities:** Operate cooling/clean-air/warming centers; HEPA filtration; inclusive access; public programming.
- **Finance & Procurement:** Climate criteria in tenders; whole-life costing; grant tracking and reporting.
- **Emergency Management & Fire:** Hazard-specific playbooks; exercises; alerts; after-action reviews; vulnerable registry.

Other supporting partnerships and roles include:

- **Regional Partners:** Pembina Valley Water Co-op, Manitoba Hydro, Rhineland CARE, regional health authority, watershed districts, neighboring municipalities, Indigenous communities, NGOs.
- **Awareness, communications and training:** possible addition
- **Monitoring and corrective actions:** ensure they stay the course and gather performance metrics
- **Audits and continual improvement:** could be included in the monitoring to simplify. Provides essential info to CAO & team plus to Council for decisions making – keeps them on track.

7.4 Integration with Other Municipal Plans (e.g., Asset Management, Development Plan)

Adaptation will be embedded across municipal planning instruments. The **Asset Management Plan** will incorporate climate risk scores and asset criticality, prioritize renewal and upsizing in high-risk corridors, and inventory **natural assets** with defined maintenance cycles. The **Development Plan, zoning, and engineering standards** will require site-level storage and infiltration, protect and expand natural drainage corridors and wetlands, and specify minimum road elevations in mapped flow paths, along with **tree canopy targets** and permeable surface ratios. The **Emergency Management Plan** will include hazard-specific playbooks with activation triggers for cooling and clean-air centers and coordinated communications. The **Procurement Policy** will emphasize whole-life costs, resilience benefits, and design specifications that perform under local hazards. The **Capital Plan and budget** will phase early wins—such as inlet upgrades, debris programs, and backflow devices—while preparing medium- to long-term storage and road elevation projects.

7.5 Regional Collaboration

Regional collaboration is essential to address shared systems and cross boundary hazards. The Town will formalize protocols with the Pembina Valley Water Coop for contingency supply and aligned restrictions, and coordinate drainage and hydrology with watershed districts and neighboring municipalities to manage upstream and downstream conveyance, including Buffalo Creek considerations. Partnerships with regional health authorities will align heat health and smoke alerts and staffing support for community centers. Collaboration with Manitoba Hydro will focus on vegetation management, reinforcement or undergrounding in priority corridors, and mutual aid for rapid

restoration. Joint exercises and shared equipment pools—such as pumps, generators, and HEPA units—will strengthen readiness across the region.

7.6 Monitoring, Indicators, and Reporting

Progress will be tracked through a concise dashboard and reported annually to Council with a public summary, which will track the following:

Flood & Stormwater

- Flood/ponding incidents at mapped hotspots (#/year).
- Catch basin/culvert proactive cleaning (% completed vs. plan).
- Added stormwater storage (m³)
- Upsized conveyance (m).
- Sanitary I/I repairs completed (# per year); backflow devices installed (#).

Water Security

- Treated-water storage buffer (days of peak demand).
- Peak-day demand vs. capacity (%) during heat waves.
- Leak rate (% non-revenue water);
- Conservation program participation (#).

Community Well-Being & Access

- Cooling/clean-air/warming center activation (hours, visits).
- Heat-health and smoke advisories issued (#); outreach contacts to vulnerable residents (#).
- Backup power readiness at health/care facilities (%).

Nature-Based Assets

- Urban canopy coverage (%) and trees planted/maintained (#).
- Permeable surface and rain garden area added (m²).

Governance & Capacity

- Capital projects applying climate lens (% or \$).
- Staff/council trainings and emergency exercises (#).
- External funding secured (\$) and projects advanced (#).
- After-action reviews completed within 60 days of events (%).

Reporting cadence

- **Quarterly** internal reviews (Adaptation Working Group).
- **Annual** public dashboard & narrative to Council.
- **Event after-action** report within 60 days of major incidents.

7.7 Review and Update Cycle

This Climate Adaptation Plan is a living document. It will be formally reviewed every **three to five years**, or sooner if triggered by the following:

- A major climate-related disaster or system failure
- Significant updates to climate projections or regulatory requirements
- Major changes to municipal infrastructure, growth patterns, or service delivery

Interim updates will be made as actions are completed, as new information becomes available, or to include lessons learned to continuously improve the Plan. The CAO and senior management are responsible for initiating reviews. Council approval is required for substantive revisions.

7.8 Adaptive Capacity Building

In addition to infrastructure improvements, climate resilience depends on the Town's capacity to anticipate, respond to, and learn from changing conditions over time. Organizational adaptive capacity refers to the governance practices, decision-making tools, and institutional knowledge that enable continuous improvement.

This Plan strengthens adaptive capacity by embedding climate considerations into existing municipal processes, including capital planning, asset management, emergency preparedness, and annual budgeting. The stepwise implementation roadmap, concise monitoring framework, and after-action review process provide practical mechanisms for tracking progress, identifying emerging risks, revising priorities as needed, and continually improve the Plan.

By clearly defining implementation roles, integrating monitoring into regular management review cycles, and aligning actions with defined workflows, the Town of Altona can enhance resilience without creating a significant additional administrative burden.

8. USE OF ARTIFICIAL INTELLIGENCE

Generative Artificial Intelligence, specifically M365 CoPilot, assisted in the development of this report. AI was used to improve the report's readability and flow, and to summarize survey results. All data analysis and final conclusions were independently verified and finalized by the human authors, who take full responsibility for the accuracy and integrity of the content.

9. CLOSURE

Prepared for:

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We trust this document meets your present requirements. If you have any questions or comments, please contact the undersigned.

Green Sky

Prepared by:

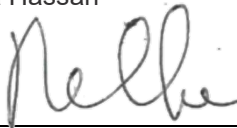


Issa Hassan

February 12, 2026

Date

Reviewed by:



Nelson Lee, P.Eng.

February 12, 2026

Date

10. APPENDIX SECTIONS

A. SUMMARY OF VISION AND RISK WORKSHOPS

A.1. Vision and Priorities Workshop — Key Discussion Points and Outcomes

A facilitated Vision and Priorities Workshop was held to support the development of the Town of Altona's Climate Adaptation Plan. The workshop brought together municipal staff and community representatives to build a shared understanding of local climate risks, define a long-term vision for a climate-resilient Altona, and identify priority areas for action. The following people participated in this workshop:

Name	Organization	Title
Dan Gagné	Town of Altona	CAO
Barry Friesen	Town of Altona	Assistant Municipal Emergency Coordinator
Clint Derksen	Town of Altona	Public Works Manager
Dan Defer	Altona Police Service	Chief
Greg Zimmerman	Altona Rhineland Emergency Service	Chief
Perry Batchelor	Town of Altona	Municipal Emergency Coordinator / Councillor
Eric Hildebrand	Town of Altona	Recreation Services Manager
Sarah Cail	Town of Altona	Manager of Community Services
Terry Fehr	Town of Altona	Finance Manager

A.1.1. Workshop Objectives

The workshop was designed to:

- Ground adaptation planning in local experience and operational realities
- Develop a shared vision of climate resilience for Altona
- Identify and prioritize key focus areas for adaptation action
- Discuss implementation barriers, opportunities, and next steps

A.1.2. Workshop Approach

The session followed a structured, participatory agenda:

1. Climate Risk Snapshot

Participants were presented with a brief overview of observed and projected climate trends affecting Altona. This framing exercise focused discussion on how climate risks may affect municipal operations, infrastructure, and long-term community objectives.

2. Visioning Exercise

Participants worked in small groups to respond to the question:

"In 20 years, what does a climate-resilient Altona look like?"

Each group developed multiple vision statements, which were then shared and clustered to identify common themes.

3. Identifying Priorities

Building on the shared vision, participants reviewed a set of adaptation focus areas tailored to Altona and collaboratively identified priority areas for action.

4. Barriers and Opportunities

A guided discussion explored key barriers to implementation (e.g., funding, staff capacity, jurisdictional complexity) alongside opportunities such as partnerships, external funding programs, and co-benefits with economic development and quality of life.

5. Roles and Next Steps

The workshop concluded with agreement on draft vision themes, priority areas, and the role of the Climate Adaptation Plan in advancing these outcomes. The final vision agreed upon is presented in both the introduction to this report and section A.1.5.

A.1.3. Key Outcomes

Shared Vision Themes

- Reliable infrastructure and municipal services during climate events
- Resilient water supply and wastewater treatment systems
- An inclusive community that protects vulnerable populations
- Sustainable and progressive community growth

Priority Adaptation Areas

- Governance and emergency preparedness
- Public health and vulnerable populations
- Flood and stormwater management
- Infrastructure resilience (roads, water, power)
- Ecosystems and green spaces

A.1.4. Role in the Adaptation Plan

The outcomes of this workshop directly informed the **adaptation goals, priority actions, and implementation framework** presented in this Climate Adaptation Plan. The process ensured that proposed actions reflect community values, municipal capacity, and locally relevant climate risks.

A.1.5. Collective Vision

Altona is a safe, sustainable, and forward-thinking community where residents are protected, connected, and empowered to thrive in a changing climate. We build reliable infrastructure, maintain secure water systems, offer inclusive services, and look after our natural surroundings to help us handle severe weather. By working together and staying prepared, we protect our people, our homes, and our future.

A.2. Risk Assessment Workshop — Process, Systems Analyzed, and Findings

The Risk Assessment Workshop (Day 2) brought together Town staff and community stakeholders to identify and prioritize the Town of Altona's most significant climate-related risks across municipal infrastructure, essential services, and community well-being. The following people participated in the workshop:

Name	Organization	Title	Stakeholder Group
Dan Gagné	Town of Altona	CAO	Government
Sarah Cail	Town of Altona	Manager of Community Services	Government
Clint Derksen	Town of Altona	Public Works Manager	Government, Outdoor Labourers
Stephanie Peters	Altona Rhineland Economic Development	Economic Development Officer	ARED, Chamber of Commerce, Business Leaders
Scott Godard	Border Land School Division	Safety Coordinator	Safety coordinators
Aaron Schmidt	Town of Altona	Public Works Foreman	Government, Outdoor Labourers
Jackson Enns	Town of Altona	Utilities Foreman	Government, Outdoor Labourers
Paul Peters	The Community Exchange	Executive Director	Transportation, Vulnerable Populations
Joel Martin	Altona Community Action Network	Member	ACAN
Eric Hildebrand	Town of Altona	Recreation Services Manager	Government
Steve Funk	Town of Altona	Recreation Services Foreman	Government, Outdoor Labourers
Ryan Potter	Blue Sky Opportunities	Executive Director	Transportation, Vulnerable Populations

The workshop built on the climate context review and focused on four priority climate hazards identified as most relevant to Altona:

- Flooding / Extreme Rainfall
- Drought and Extreme Heat
- Gust Winds and Tornadoes
- Air Quality (Wildfire Smoke)

A.2.1 Workshop Objectives

The workshop was designed to:

- Confirm priority hazards based on local experience and observed impacts
- Identify exposed systems, service dependencies, and vulnerable populations
- Apply a consistent scoring approach to rank risks by likelihood and consequence
- Validate risk rankings through facilitated discussion and consensus
- Generate a prioritized foundation for adaptation directions and actions

A.2.2 Systems Analyzed

Workshop participants assessed climate impacts across a practical cross-section of community systems and municipal service areas. The analysis included both critical services and infrastructure systems.

Critical services (community-facing and economic systems) assessed in the workshop included:

- Educational services
- Health care and social assistance
- Transportation and warehousing
- Accommodation
- Food services
- Administrative and support services
- Waste management

Infrastructure and built environment systems assessed in the workshop included:

- Buildings (residential, commercial, and institutional)
- Water networks and water supply management systems
- Sanitary networks
- Stormwater network
- Roads and associated structures
- Electricity distribution
- Recreation centres

Local economy systems assessed included:

- Manufacturing
- Construction
- Retail and Wholesale Trade
- Agriculture, Forestry, Fishing and Hunting
- Arts, Entertainment and Recreation
- Finance and Insurance

The natural environment assessed included:

- Open space and parkland
- Land associated with municipal facilities
- Land maintained for environmental purposes
- Off-road trails
- Park structures

A.2.3 Risk Scoring Method

Participants used a structured risk-ranking approach to assess each hazard against the systems analyzed. Each hazard–system interaction was scored using two dimensions:

- Likelihood (1–5): the expected frequency of occurrence under current and future conditions
- Severity/Consequence (1–5): the potential magnitude of impact on public safety, service delivery, infrastructure function, and social/economic disruption

The likelihood and severity ratings used are shown in the table below.

Table A.2.1. Likelihood Rating

Score	Likelihood	
1	Very low	Not likely to occur in period
2	Low	Likely to occur once between 30 and 50 years
3	Moderate	Likely to occur once between 10 and 30 years
4	High	Likely to occur at least once a decade
5	Very high	Likely to occur once or more annually

Table A.2.2. Severity/consequence Rating

Score	Severity			
1	Very low	Measurable	Some measurable change	Not likely to become critical / beneficial in period
2	Low	Minor	Moderate loss of serviceability	Likely to become critical / beneficial in 30-50 years
3	Moderate	Moderate	Major loss of serviceability, some loss of function	Likely to become critical / beneficial in 10-30 years
4	High	Major	Major loss of serviceability, some loss of function	Likely to become critical / beneficial in a decade
5	Very high	Serious	Major, loss of function	Will become critical / beneficial within several years

These scores were combined into an overall risk rating (Likelihood × Severity) to support consistent comparison across hazards and systems using the following risk rating matrix:

Consequences	Very High	Moderate Risk	High Risk	High Risk	Extreme Risk	Extreme Risk
High	Low Risk	Moderate Risk	High Risk	High Risk	High Risk	Extreme Risk
Moderate	Low Risk	Low Risk	Moderate Risk	High Risk	High Risk	High Risk
Low	Negligible Risk	Low Risk	Low Risk	Moderate Risk	Moderate Risk	Moderate Risk
Very Low	Negligible Risk	Negligible Risk	Low Risk	Low Risk	Low Risk	Low Risk
	Very Low	Low	Moderate	High	Very High	Very High
Likelihood						
Extreme Risk (Red): Immediate controls required High Risk (Orange): High priority control measures required Moderate Risk (Yellow): Some controls required to reduce risks to lower levels Low Risk (Blue): Controls likely not required Negligible Risk (Green): Risk events do not require further consideration						

Figure A.2.1: Risk Rating

Workshop results were consolidated into risk tables and used to identify priority risks for adaptation planning. Below is the summary of the risk identified during the workshop:

Systems	Drought / Extreme heat	Flooding	Gusty winds / Tornado	Air quality
	Risk rating	Risk rating	Risk rating	Risk rating
Critical Services		-	-	-
Educational Services	10	8	0	0
Health care and Social Assistance	15	16	0	8
Transportation and Warehousing	10	4	0	0
Accommodation	15	4	0	0
Food Services (restaurant, grocery)	15	0	0	0
Waste Management (collection and disposal)	10	4	0	0
Infrastructure				
Buildings (Residential, commercial and Institutional)	5	8	6	0
Sanitary networks	0	20	0	0
Stormwater network	0	12	0	0
Roads and associated structures	5	8	3	0
Water supply and management systems	0	0	0	0
Electricity distribution	0	4	9	0
Airport infrastructure	0	0	6	0
Recreation Centres	15	0	6	0
Local Economy				
Manufacturing	5	0	0	0
Construction	5	20	0	0
Retail and Wholesale Trade	0	0	3	0
Agriculture	20	0	0	0
Arts, Entertainment and Recreation	0	12	0	0
Finance and Insurance	5	4	0	0
Natural Environment				
Open space and parkland	5	4	3	0
Land associated with municipal facilities	5	0	0	0

Note: 0 indicates that the climate hazard is not expected to have a sensible impact on the system under study.

A.2.4 Key Findings by Hazard

Flooding / Extreme Rainfall emerged as the highest priority hazard overall, with the most significant impacts associated with underground infrastructure systems. The highest-ranked flooding risk was associated with sanitary networks, reflecting the potential for system overload, backups, and service disruption during major rainfall events. Flooding was also identified as a high priority for stormwater systems, roads, and buildings, with cascading effects on emergency response and community safety.

Drought and Extreme Heat produced elevated risk scores across a broad range of critical services. The results indicate that heat and drought risks are strongly linked to community well-being and operational continuity, with particularly high impacts associated with health care and social assistance and service continuity pressures affecting accommodation and food services. Participants noted that prolonged dry periods and higher temperatures increase health vulnerabilities, amplify demand pressures, and may require enhanced municipal and community preparedness.

Gusty Winds and Tornadoes were identified as a disruption-focused hazard, with the most significant impacts linked to electricity distribution and outage-driven cascading effects. Participants noted that severe wind events can cause debris hazards, localized damage, and interruptions to services and communications. While wind risks were generally less widespread across all systems compared to flooding, the consequences of outages and access disruption can be significant during severe events.

Air Quality (Wildfire Smoke) was identified as a recurring seasonal hazard affecting residents' health and safe participation in outdoor activities. Participants highlighted the importance of preparedness measures that support continued community services during smoke events, including public communications and access to indoor spaces with adequate air filtration.

A.2.5 Cross-Cutting Vulnerabilities and Considerations

Across all hazards, participants identified several shared vulnerabilities that increase overall climate risk. These include aging infrastructure systems, critical service dependencies (such as power reliability and transportation access), and heightened sensitivity among vulnerable populations, including seniors, people with chronic illness, and households with limited resources to adapt. Participants also emphasized the importance of clear, practical, hazard-focused communications that support preparedness and safety.

A.2.6 Summary of Highest-Priority Risks

The risk-ranking results indicate three priorities for adaptation planning. First, flooding impacts on sanitary and stormwater systems represent the highest overall infrastructure risks and should remain a central focus for maintenance planning, capital investment, and response coordination. Second, drought and extreme heat impacts on community well-being and essential services are significant and increasing, requiring preparedness planning for vulnerable populations, continuity of services, and water management. Third, wind-driven power disruptions and continuity risks require practical readiness measures, including outage planning, communications strategies, and resilience planning for facilities.

These workshop findings were used to establish the Climate Risk and Vulnerability priorities in Section 4 and directly informed the Strategic Directions and Adaptation Actions presented in Sections 5 and 6.

B. COMMUNITY SURVEY RESULTS

This appendix summarizes what residents said about extreme weather impacts across power, roads, schools, healthcare and more, and it highlights priority actions for climate adaptation. It is divided into two sections; the first one lists the questions and the second shows the results.

B.1. Questions

Below are the questions included in the survey:

Resident profile:

- Do you live in Altona?
- What is your age? (Why we ask: Different age groups can face different risks from extreme weather, such as heat, cold, or storms.)
- What is your housing situation? (Why we ask: Whether people rent, own, or have other living arrangements can affect how easily they can prepare for or recover from climate impacts.)
- Are you Indigenous (First Nations, Métis, or Inuit)? (Why we ask: Indigenous communities may have unique knowledge, experiences, and risks related to climate change.)
- Have you lived in Canada for less than 10 years? (Why we ask: People who are newer to Canada may face added challenges, such as limited networks or access to information during emergencies.)
- Do you consider yourself part of a racialized or visible minority group? (Why we ask: Racialized groups may experience different barriers to resources, services, or recovery support during climate events.)
- Do you identify as a person with a disability? (Why we ask: People with disabilities may face added risks during extreme weather, such as mobility challenges, health needs, or barriers to accessing emergency services.)
- Which of the following best describes your current work? (Why we ask: Some types of work are more directly affected by heat, storms, or other climate impacts.)

Comments on access to education:

- How concerned are you about extreme weather affecting schools or other places of learning? Extreme Heat & Drought
- How concerned are you about extreme weather affecting schools or other places of learning? Tornadoes/Gust Winds
- How concerned are you about extreme weather affecting schools or other places of learning? Heavy Rain & Flooding
- How concerned are you about extreme weather affecting schools or other places of learning? Blizzards, ice storms, heavy snowfall

Comments on access to healthcare:

- How concerned are you about extreme weather affecting health care or social supports (doctor visits, hospital, community services)? Extreme Heat & Drought
- How concerned are you about extreme weather affecting health care or social supports (doctor visits, hospital, community services)? Tornadoes/Gust Winds
- How concerned are you about extreme weather affecting health care or social supports (doctor visits, hospital, community services)? Heavy Rain & Flooding
- How concerned are you about extreme weather affecting health care or social supports (doctor visits, hospital, community services)? Blizzards, ice storms, heavy snowfall

Comments on travel and transportation:

- How concerned are you about extreme weather affecting travel and getting around town? Extreme Heat & Drought
- How concerned are you about extreme weather affecting travel and getting around town? Tornadoes/Gust Winds
- How concerned are you about extreme weather affecting travel and getting around town? Heavy Rain & Flooding
- How concerned are you about extreme weather affecting travel and getting around town? Blizzards, ice storms, heavy snowfall

Comments on access to Town services:

- How concerned are you about extreme weather affecting access to Town services (Town office, essential services)? Extreme Heat & Drought
- How concerned are you about extreme weather affecting access to Town services (Town office, essential services)? Tornadoes/Gust Winds
- How concerned are you about extreme weather affecting access to Town services (Town office, essential services)? Heavy Rain & Flooding
- How concerned are you about extreme weather affecting access to Town services (Town office, essential services)? Blizzards, ice storms, heavy snowfall

Comments on your home in extreme weather:

- How concerned are you about extreme weather affecting your home? Extreme Heat & Drought
- How concerned are you about extreme weather affecting your home? Tornadoes/Gust Winds
- How concerned are you about extreme weather affecting your home? Heavy Rain & Flooding
- How concerned are you about extreme weather affecting your home? Blizzards, ice storms, heavy snowfall

Comments on accessing workplace/ability to work:

- How concerned are you about extreme weather affecting your workplace or your ability to work? Extreme Heat & Drought
- How concerned are you about extreme weather affecting your workplace or your ability to work? Tornadoes/Gust Winds
- How concerned are you about extreme weather affecting your workplace or your ability to work? Heavy Rain & Flooding
- How concerned are you about extreme weather affecting your workplace or your ability to work? Blizzards, ice storms, heavy snowfall

Comments on water and wastewater services:

- How concerned are you about extreme weather affecting water and wastewater services (clean drinking water, sewer system)? Extreme Heat & Drought
- How concerned are you about extreme weather affecting water and wastewater services (clean drinking water, sewer system)? Tornadoes/Gust Winds
- How concerned are you about extreme weather affecting water and wastewater services (clean drinking water, sewer system)? Heavy Rain & Flooding
- How concerned are you about extreme weather affecting water and wastewater services (clean drinking water, sewer system)? Blizzards, ice storms, heavy snowfall

Comments on power and electricity:

- How concerned are you about extreme weather affecting power and electricity? Extreme Heat & Drought
- How concerned are you about extreme weather affecting power and electricity? Tornadoes/Gust Winds
- How concerned are you about extreme weather affecting power and electricity? Heavy Rain & Flooding
- How concerned are you about extreme weather affecting power and electricity? Blizzards, ice storms, heavy snowfall

Comments on recreation spaces:

- How concerned are you about extreme weather affecting recreation spaces (pool, arena, community centres)? Extreme Heat & Drought
- How concerned are you about extreme weather affecting recreation spaces (pool, arena, community centres)? Tornadoes/Gust Winds
- How concerned are you about extreme weather affecting recreation spaces (pool, arena, community centres)? Heavy Rain & Flooding
- How concerned are you about extreme weather affecting recreation spaces (pool, arena, community centres)? Blizzards, ice storms, heavy snowfall

Comments on extreme weather's impact on income:

- How concerned are you about extreme weather affecting your household finances or income? Extreme Heat & Drought
- How concerned are you about extreme weather affecting your household finances or income? Tornadoes/Gust Winds
- How concerned are you about extreme weather affecting your household finances or income? Heavy Rain & Flooding
- How concerned are you about extreme weather affecting your household finances or income? Blizzards, ice storms, heavy snowfall

Comments on parks and recreation spaces:

- How concerned are you about extreme weather affecting local parks and outdoor spaces? Extreme Heat & Drought
- How concerned are you about extreme weather affecting local parks and outdoor spaces? Tornadoes/Gust Winds
- How concerned are you about extreme weather affecting local parks and outdoor spaces? Heavy Rain & Flooding
- How concerned are you about extreme weather affecting local parks and outdoor spaces? Blizzards, ice storms, heavy snowfall

Comments on cultural or historic sites:

- How concerned are you about extreme weather affecting cultural or historic sites in town? Extreme Heat & Drought
- How concerned are you about extreme weather affecting cultural or historic sites in town? Tornadoes/Gust Winds
- How concerned are you about extreme weather affecting cultural or historic sites in town? Heavy Rain & Flooding
- How concerned are you about extreme weather affecting cultural or historic sites in town? Blizzards, ice storms, heavy snowfall

Others:

- Please share any additional comments, reflections, concerns or ideas about the impact that Extreme Heat and Drought could have on you, your family or your community.
- Please share any additional comments, reflections, concerns or ideas about the impact that Tornadoes or Gust Winds could have on you, your family or your community.
- Please share any additional comments, reflections, concerns or ideas about the impact that Heavy Rain or Flooding could have on you, your family or your community.
- Please share any additional comments, reflections, concerns or ideas about the impact that Blizzards, Ice Storms or Heavy Snowfall could have on you, your family or your community.

B.2. Results

1. Who Responded

- Responses: 53; live in Altona: 51
- Age: top groups were 18-44 (32), 45-64 (17), 65+ (3), Under 18 (1)
- Housing: I own my home (48), Other (2), I rent my home (2), Prefer not to say (1)
- Indigenous identity (Yes): 3; Prefer not to say: 3
- Lived in Canada < 10 years (Yes): 1

2. What the Ratings Say

Overall concern distribution

- Very unconcerned: 38.4%
- Somewhat unconcerned: 9.1%
- Neutral: 17.5%
- Somewhat concerned: 20.1%
- Very concerned: 14.9%

Top services where people feel most at risk

Average share who are somewhat or very concerned across hazards:

- Power & electricity: 26.9%
- Home: 21.7%
- Healthcare & social supports: 21.4%
- Water & wastewater: 21.0%
- Schools & learning: 19.8%
- Parks & outdoor spaces: 17.0%
- Travel & mobility: 16.7%
- Household finances: 15.6%
- Work & ability to work: 15.3%
- Cultural & historic sites: 13.9%
- Town services: 11.3%
- Recreation spaces: 9.6%

Which hazards worry people most (on average)

- Winter storms: 19.9% somewhat+very concerned
- Heavy rain & flooding: 19.0% somewhat+very concerned
- Tornadoes & gusty winds: 16.1% somewhat+very concerned
- Extreme heat & drought: 15.1% somewhat+very concerned

3. What People Talked About (from open comments)

Cross-cutting themes (count of mentions)

- Power reliability & outages: 32
- Water supply & quality: 29
- Snow & ice operations: 27
- Drainage, sewer & flooding: 26
- Trees & branches: 22
- Healthcare access: 15
- Heat relief & cooling: 14
- Risk comms & alerts: 12

4. Hazard-specific themes (what spikes where)

Extreme heat & drought

- Water supply & quality: 14
- Heat relief & cooling: 10
- Trees & branches: 3
- Power reliability & outages: 1
- Risk comms & alerts: 1
- Drainage, sewer & flooding: 0
- Snow & ice operations: 0
- Healthcare access: 0

Tornadoes & gust winds

- Trees & branches: 11
- Power reliability & outages: 9
- Risk comms & alerts: 8
- Heat relief & cooling: 1
- Water supply & quality: 1
- Drainage, sewer & flooding: 0
- Snow & ice operations: 0
- Healthcare access: 0

Heavy rain & flooding

- Drainage, sewer & flooding: 20
- Water supply & quality: 8
- Power reliability & outages: 3
- Trees & branches: 2
- Heat relief & cooling: 1
- Risk comms & alerts: 1
- Snow & ice operations: 0
- Healthcare access: 0

Winter storms

- Snow & ice operations: 21
- Power reliability & outages: 12
- Healthcare access: 3
- Trees & branches: 3
- Heat relief & cooling: 2
- Water supply & quality: 1
- Risk comms & alerts: 1
- Drainage, sewer & flooding: 0

5. Overall Sentiment (what this means)

- Polarized views: some want proactive upgrades; others feel weather is routine and oppose new spending.
- Despite differences, practical fixes—reliable power, better drainage, faster snow/ice operations—draw broad support.
- Equity gap: Indigenous residents and newcomers are underrepresented; targeted engagement will improve planning.

6. How to Read These Results (methods & caveats)

- Open, self-selected survey; not a randomized sample. The results are considered as directional community input, not a census.
- Percentages reflect the share of answers in each category across all rating questions; “somewhat+very concerned” aggregates two top boxes.

B.3. Interpretation

The survey gathered input from 53 Altona residents, offering valuable insights into local experiences and priorities related to extreme weather and service reliability. While the survey provides a directional snapshot of community sentiment, it also highlights key gaps in representation that must be addressed in future engagement efforts.

1. Community Participation: Representative but Incomplete

The majority of respondents (51 of 53) live in Altona, and nearly all (48) are homeowners, indicating strong participation from long-term residents with vested interests in property protection and community resilience.

Demographics:

Most respondents are between 18 and 64 years old (49 participants), with a concentration among those aged 18-44 (32 participants). Employment is largely within office/service (19), healthcare/education (14), and outdoor labour (9) sectors, with six participants commuting out of town for work or Schooling.

Representation Gaps:

Several key community groups were underrepresented or absent:

- Indigenous residents (3 respondents) and new commers – missing perspectives that could offer cultural, historical, and environmental insight, as well as highlight unique barriers during emergencies.
- Renters (2 respondents) – a population with limited control over housing resilience measures.
- Seniors (3 respondents) – particularly vulnerable to heat and power disruptions.
- Youth (1 respondent) – the generation most impacted by long-term climate change was almost entirely unrepresented.

This self-selected participation pattern underscores the need for targeted outreach to ensure future engagement captures the voices of all community segments, especially those most at risk.

2. Community Concerns: Divided Beliefs, Shared Priorities

While the community expressed mixed views on the causes of climate change, residents demonstrated strong alignment around practical concerns—particularly the reliability of essential services during extreme weather events.

Quantitative Findings:

Top Services of Concern:

- Power & Electricity
- Healthcare & Emergency Access
- Water & Wastewater Systems

Top Hazards Identified:

- Winter Storms
- Heavy Rain and Flooding
- Extreme Heat & Drought were of lowest concern overall but still mentioned in relation to vulnerable populations.

3. Key Themes from Open-Ended Responses

Power Reliability:

Power outages were the single most mentioned issue (32 comments). Residents described “constant outages,” often caused by overgrown trees near above-ground lines. Suggested solutions included proactive vegetation management and investments in underground infrastructure.

Flooding & Drainage:

Localized flooding—especially on 4th Street SW near Elmwood School and nearby sports fields—was frequently reported. Residents observed overwhelmed stormwater systems and recommended culvert gates, green infrastructure, and capacity upgrades.

Healthcare Access:

Concerns about emergency room closures and delayed ambulance response times were amplified by fears that extreme weather will further strain these already fragile systems. Respondents emphasized the need for continuity of healthcare services during storms or power loss.

Snow & Ice Clearing:

Frequent requests were made for faster and more effective road and sidewalk clearing, particularly around hospitals, schools, and key commuter routes. Respondents directly linked inadequate snow clearing to lost wages and safety risks.

Vulnerable Populations:

Although seniors and low-income households were underrepresented, respondents consistently voiced worry for those without air conditioning or mobility during heatwaves and power outages.

4. Community Sentiment and Framing Opportunities

Nearly half of participants (47.5%) reported being unconcerned or skeptical about climate change itself. However, this same group expressed strong support for investments in reliable power, drainage, healthcare access, and snow clearing—highlighting a shared, pragmatic interest in community safety and service reliability.

This suggests a key communication opportunity: framing climate adaptation not as a “climate” issue but as a core service improvement strategy that benefits all residents—regardless of beliefs about climate change.

5. Overall Insight

The survey paints a picture of a practical, community-minded population focused on tangible improvements to infrastructure and emergency preparedness. While the dataset is limited by demographic gaps, it clearly identifies power reliability, drainage, healthcare access, and winter maintenance as the top local resilience priorities. These findings provide a solid foundation for aligning Altona’s Climate Adaptation Plan with public expectations and lived experiences.

C. TECHNICAL FLOOD ANALYSIS MAPS AND DATA

This appendix provides a comprehensive overview of the methodology and tools used to model a 1-in-200-year rainfall event-induced flood in and around the Town of Altona, Manitoba. This analysis builds on the physical context described in section 2.3 and supports the findings discussed in section 2.4. It outlines the data sources, GIS-based hydrological modeling techniques, rainfall simulation procedures, and criteria used to identify flood prone areas. Flood prone area identification, key findings and implications, and limitations are all discussed in section 2.4 and supported by the information provided below.

C.1. Data Sources

Below is a summary of the inputs used and their sources.

Table C.1: Inputs

Input	Source
DEM of UTM 14 for Altona, 2 m resolution	Index of public elevation, Government of Canada geospatial data files
Landcover map, 30 m resolution	Canada open-source geospatial information (Geo.ca)
Open street maps	Openstreetmaps.org
Soil characteristics	Canada – Manitoba Soil Survey Report, 1993 Soil map Plum Coulee Description

C.2. Tools and Plugins Used

Below is a table showing the various tools and plug-ins used for this analysis.

Table C.2: Tools and Plug-ins used

Tool	Plug-in
Clip Raster by Extent	QuickOSM (Open Street Maps)
Warp (reproject)	Processing Saga NextGen Provider
Fill Sinks (Wang & Liu)	GRASS GIS Processing Provider
Flow Accumulation (Top-Down)	
Zonal Statistics	
Join Attributes by Location (Summary)	
Polygonize (raster to vector)	
Raster Pixel to Points	
Add Raster Values to Points	

C.3. Data Processing

The raw files were first clipped by extent to the study area and reprojected to a common coordinate system. The DEMs to be used were then filled to remove any pits that would cause the analysis to halt in these areas. From this, slope, flow direction, and flow accumulation were obtained using Flow Accumulation (top-down) or watershed. The flow accumulation was calculated using cell area and a multiple-flow-direction method due to the relative low slope of the study area. Slope and soil characteristics of the region were used to estimate runoff coefficient (C) values for different land covers. These values were then assigned a number associated with pixel colours from the Canada land cover map to create a spatial variable C Map.

C.3.1. Soil Characteristics

Soil characteristics and land cover can play a significant role in runoff volume. The majority of soil surrounding the town is said to be Plum Coulee soil type, according to historic soil surveys of the region. This soil type is characterized as imperfectly drained, with slow surface runoff and slow infiltration. This soil makes up a large portion of the agricultural land surrounding the town and has a high water table, all of which lead to the soil remaining wet for a significant part of the year. Landcover classes were taken from the 2020 Land Cover of Canada map, and C values for each class were estimated on the assumption of a prairie region with minimal slope, predominantly clayey soil, during the 1-in-200-year flood event of 91 mm/h. The table below lists the landcover codes and classes from the original file, the estimated coefficient, and a short rationale for this estimate.

Table C.3: Landcover C Classifications

Code	Landcover Class	Estimated Runoff Coefficient C	Rationale
1	Temperate needleleaf forest	0.32	Needleleaf + clay → slightly higher than broadleaf.
2	Taiga needleleaf forest	0.32	Same reasoning as (1).
3	(unknown)	0.3	Mid-forest/default placeholder.
4	(unknown)	0.3	Mid-forest/default placeholder.
5	Broadleaf deciduous forest	0.24	Better infiltration; slightly increased for 200-yr storm.
6	Mixed forest	0.28	Forests still reduce runoff but less so under extreme event.
7	(unknown)	0.4	Mid-value placeholder.
8	(unknown)	0.4	Mid-value placeholder — unlikely to appear
9	Temperate shrubland	0.3	Shrub cover helps infiltrate somewhat.
10	Temperate grassland	0.35	Clay reduces infiltration; increase vs. moderate storms.
11	Sub-polar shrubland	0.3	Better retention than bare but reduced under extreme rain.
12	Sub-polar grassland/lichen	0.35	Slightly higher runoff than temperate grassland under extreme event.
13	Sub-polar barren/lichen/moss	0.4	Sparse cover, limited infiltration on wet clays.

Code	Landcover Class	Estimated Runoff Coefficient C	Rationale
14	Wetland	0.3	Some attenuation still, but less effective when saturated.
15	Cropland	0.55	Intense rain + clay soils → higher runoff than gentle storms.
16	Barren	0.7	Bare/clayey surfaces crust and shed more during intense rainfall.
17	Urban / Built-up	0.92	Very high imperviousness; a little higher than before for extreme rainfall.
18	Water	1	All precipitation runs off.
19	Snow / Ice	0.85	Melting/compact snow produces high quick runoff.

C.4. Rainfall Event Simulation

To model the risk associated with a 1-in-200-year storm, a number of variables are needed. The peak stormwater runoff rate can be calculated using the rational method;

$$Q = C i A$$

Where Q is the flow rate in m/s, C is the runoff coefficient, which accounts for infiltration and landcover, i is the intensity in m/s, and A is the contributing area in m².

Assuming this is a 1-hour rainfall event, the equation can be simplified to get total runoff volume for a drainage area.

$$V_{\text{runoff}} = C P A$$

Where P is the precipitation depth in m.

In order to calculate overflow potential, the storage capacity of each cell must first be calculated. This is done by comparing the filled DEM to the original DEM. This gives the depth of the cell, and the storage volume can be calculated as

$$V_{\text{storage}} = d \times A_{\text{cell}}$$

If the runoff volume exceeds the storage volume, overflow into neighbouring cells will occur. Once each cell's storage capacity has been exceeded, ponding occurs. Using the following equations in the raster calculator:

$$(\text{"filled_DEM@1"} - \text{"DEM@1"}) * ((\text{"filled_DEM@1"} - \text{"DEM@1"}) > 0)$$

This gives a ponding depth layer which zeros out any negative depth values. Storage volume per cell can be calculated then by multiplying by the cell area (2x2 m²);

$$\text{"pond_depth@1"} * 4$$

To filter where depressions exist, the following is once again put into the raster calculator;

$$\text{"pond_depth@1"} > 0$$

This gives a depression mask, which gives a value of 1 where depressions exist, and zero where they do not. This mask is then converted to polygons using the polygonize tool, which results in a depression

polygon layer. To speed up analysis, polygons where depressions did not exist were first removed. Running the tool zonal statistics on this new layer:

- Processing Toolbox → Zonal statistics
 - Vector layer: depression polygons
 - Raster layer: storage_per_cell.tif
 - Statistics: Sum → field (e.g., stor_sum)

This sums the volume of depressions across each polygon. Now the contributing area at each depression outlet is needed. The maximum flow accumulation, which is the maximum flow arriving at each cell, can be calculated and applied to the layer just calculated.

- Run Zonal statistics again:
 - Vector: depression_polygons with stor_sum
 - Raster: flow_accum_area.tif
 - Statistic: Maximum → store as FA_max (m²)

Maximum flow accumulation is used as the contributing area in the runoff equation. If the polygon area were to be used, it would not account for all upstream runoff arriving at the inlet of the depression being analyzed.

Now the polygon layer includes storage volume and maximum flow accumulation for each depression polygon.

In order to add C values to the depressions layer, the spatial variation C map needed to be added to the flow accumulation values in the original layer. This was done by first using the raster pixel to points tool on the flow accumulation raster, then the add raster values to points tool with the C map being the value input and the accumulation points being the receiving layer. The join attributes by location (summarize) tool was used on this layer to calculate and add the mean and max C values that fell within the depression polygon layer for each polygon.

Finally, runoff can be calculated for each polygon. This was done in the field calculator using the runoff equation, inputting the variable max flow accumulation for area and maximum C for the runoff coefficient. This volume is compared to the storage capacity of the polygon; by subtracting the storage capacity from the runoff volume, overflow can be calculated.

C.5. Flood Prone Area Identification

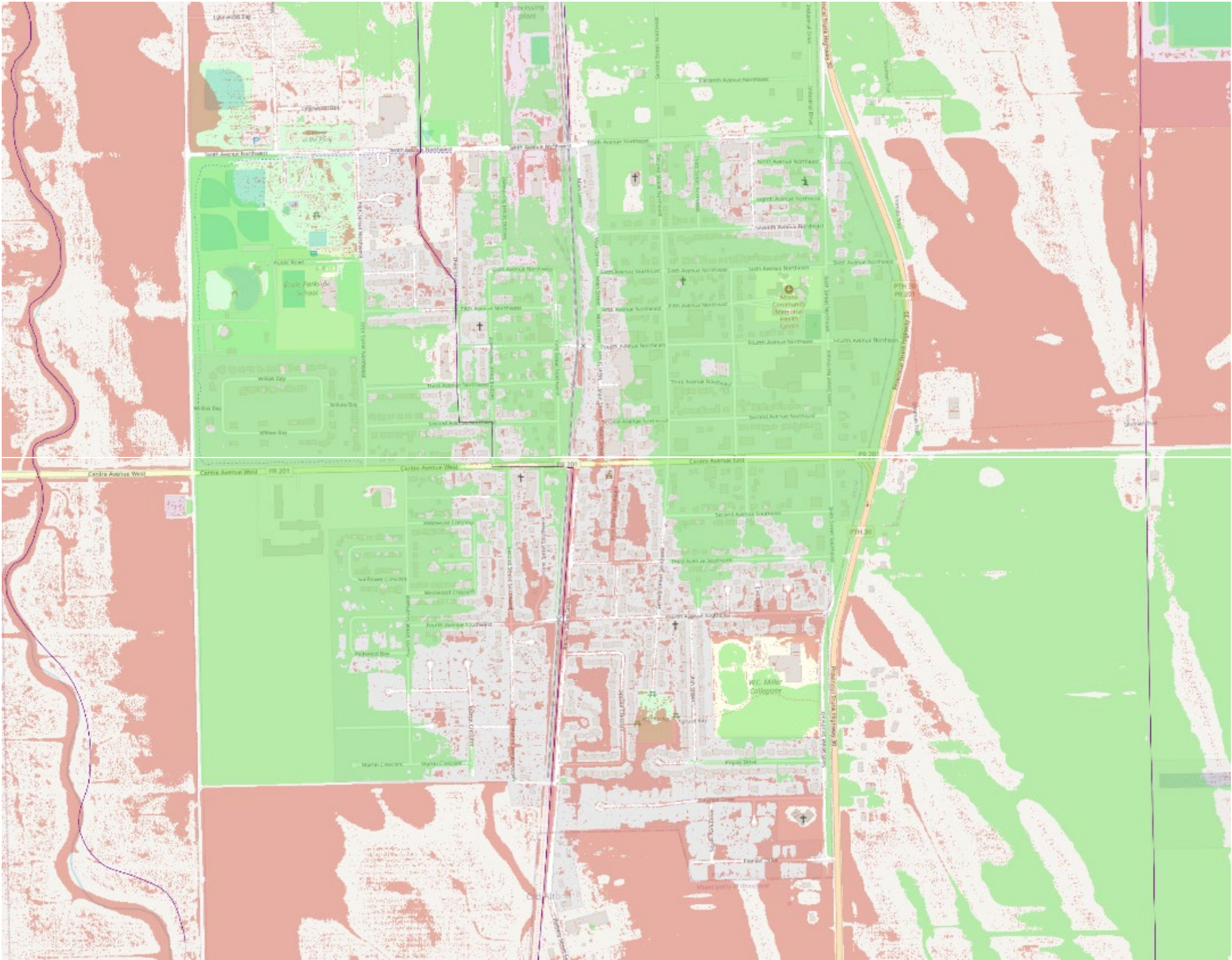
Flood prone areas can be visualized in Figure 1 and Figure 2 from section 2.4.2, *Results and Visualizations*.

C.6. Validation and Sensitivity Checks

The maps produced in section 2.4.2, *Results and Visualizations* were presented to the client to compare against historical flooding patterns experienced by the town. The identified risk areas were consistent considering the age of the elevation files available for this model.

C.7. Risk Areas in Town

The figure below is a scaled down image of the extent of the risk areas in town.



D. CLIMATE PROJECTION DATA TABLES

The analysis represented in this report relies heavily in the climate projections from the Climate Atlas of Canada, which are based on climate change indices derived from 24 statistically downscaled global climate models provided by the Pacific Climate Impacts Consortium (PCIC; pacificclimate.org), using the BCCAQv2 downscaling method. Results are reported for the high-emissions scenario (RCP8.5) and represent the full 24-model ensemble. A historical baseline period (“recent past”) of 1976–2005 is used for comparison with two future projection periods: 2021–2050 and 2051–2080. Reported low (10th percentile), mean, and high (90th percentile) values reflect the range of outcomes across the ensemble.

Below is the summary of the climate projections:

D.1. Projected Summer Change

Summer Change	Recent Past	2021-2050			2051-2080			Importance
		10th percentile	Mean	90th percentile	10th percentile	Mean	90th percentile	
 Typical hottest summer day	35.3 °C	34.3 °C	37.8 °C	41.4 °C	36.5 °C	40.5 °C	44.5 °C	Measure of extreme heat that affects social and ecological systems
 Number of +30 °C days per year	19	17	37	59	32	60	85	Indicator of summer severity that affects human health, recreation, ecosystems, impacts on machinery operations and equipment failure
 Number of +20 °C nights per year	1	1	7	16	5	22	41	Impacts on human health including psychological stress and heat stroke, increased A/C and energy usage
 Number of heatwaves*	3	2	5	8	3	6	10	Causes heat-related illnesses, and strain on social services such as emergency rooms, shelters, community structures
 Summer precipitation	216 mm	120 mm	218 mm	320 mm	114 mm	208 mm	322 mm	Affects water availability, risk of drought, stormwater issues

D.2. Projected Spring and Fall Change

Spring and Fall Seasons	Recent Past	2021-2050			2051-2080			Importance
		10th percentile	Mean	90th percentile	10th percentile	Mean	90th percentile	
 Date of last spring frost	May 13	April 15	May 4	May 21	April 4	April 25	May 13	Defines the start of growing season, and the return of summer
 Date of first fall frost	Sept. 29	Sept. 23	Oct. 10	Oct. 27	Oct. 1	Oct. 19	Nov. 5	Affects plants, animals, and experience of seasons
 Spring precipitation	123 mm	69 mm	137 mm	220 mm	77 mm	145 mm	226 mm	Affects seeding and planting of crops, spring flood risk
 Fall precipitation	108 mm	57 mm	116 mm	186 mm	61 mm	116 mm	189 mm	Impacts surface and soil moisture
 Length of frost-free season (days)	136	131	155	182	146	173	202	Indicator of the length of the growing season.

D.3. Projected Winter Change

Winter Change	Recent Past	10th percentile	2021-2050 Mean	90th percentile	10th percentile	2051-2080 Mean	90th percentile	Importance
 Typical coldest winter day	-34.2 °C	-34.5 °C	-30.4 °C	-26.2 °C	-31.3 °C	-26.2 °C	-20.8 °C	Affects safety, recreation, buildings, transportation use, energy use, etc.
 Number of -15 °C days per year	73	33	55	77	15	36	59	An indication of how much heating will be required in a given year
 Winter precipitation	67 mm	43 mm	75 mm	110 mm	47 mm	80 mm	118 mm	Affects snowpack, spring flooding, and ground insulation
 Number of -30 °C days per year	8	0	2	8	0	1	2	Affects survival and overwintering of pest and pathogens, indication of cold and
 Number of below-zero days per year	183	144	164	182	121	145	166	Measure of cold affecting snow/ice accumulation and energy use

D.4. Interpretation

Climate projections for southern Manitoba indicate that Altona will experience a warmer, more variable climate, with an increase in the frequency and severity of extreme weather events over the coming decades.

Key trends include:

- **Rising temperatures and extreme heat**
 - More days above 30°C, warmer nights, and more frequent heat waves, increasing risks to public health, energy systems, and outdoor activities.
- **Heavier rainfall and increased flood risk**
 - More intense short-duration rainfall events, higher risk of overland flooding and stormwater system exceedance, and increased spring flood risk due to rapid snowmelt on frozen ground.
- **Longer dry periods and drought risk**
 - Higher evapotranspiration and longer summer dry spells, increasing pressure on water supply, vegetation, and natural assets.
- **Changing winter conditions**
 - Milder winters with fewer extreme cold days, but more freeze–thaw cycles, winter rain, and heavier wet snowfall, increasing stress on roads, drainage systems, and underground infrastructure.
- **Shifting seasons**
 - Earlier springs and later falls, leading to a longer frost-free season and greater risk of unseasonable temperature swings.

D.5. Implications for Adaptation Planning

For Altona, climate change risk is driven primarily by increased climate extremes rather than gradual change. The most significant municipal risks relate to extreme heat, flooding, infrastructure resilience, and emergency management. These trends highlight the importance of integrating climate considerations into asset management, land-use planning, infrastructure design, and service delivery.

E. DETAILED ADAPTATION ACTION TABLES

The tables below describe the adaptation actions listed in section 6.2 of this report:

Table E.1. Adaptation actions for very high risks identified, based on the systems analyzed

Systems	Climate Hazard	Comments	Adaptation Actions		Altona comments (e.g., applicability of the measure, jurisdictional responsibility, technical challenges, etc.)
INFRASTRUCTURE					
Sanitary networks	Flooding	Infiltration into the system	Technical Measures:		The Town recently received preliminary analysis of infiltration into our sanitary sewer network and we scored very well against the industry average. We have also finished a full televised inspection of our sanitary sewer mains and will be reviewing this to identify problem areas to address.
			1	Manhole and Pipe Sealing / Rehabilitation	
				What: Inspect and seal leaky manholes, service connections, and joints (e.g., using chemical grouting, CIPP lining, or gasketed covers).	
				Why: Reduces groundwater infiltration during high water table conditions and prevents inflow from surface runoff entering the sanitary system.	
				Altona relevance: Shallow groundwater and saturated clay soils make infiltration through cracks a major issue.	Building code makes these devices mandatory but several older properties may not have them. The Town should create awareness of the issue but not necessarily subsidize installation costs.
			2	Installation of Backflow Prevention Devices	
				What: Install backwater valves (check valves) in service laterals or at critical nodes in the sewer network.	
				Why: Prevents sewage from backing up into basements and low-lying buildings when system pressure exceeds gravity flow.	
				Altona relevance: Essential in flat areas where hydraulic head differences are minimal and backup risk is high during intense storms.	Sanitary sewer network analysis did not result in this being a recommendation but Administration could follow up with its engineering consultants to determine feasibility of the concept.
			3	Additional Storage	
				What: Add surge storage (equalization basins or oversized interceptors).	
				Why: Reduces hydraulic overload on sanitary mains during rain events.	
				Altona relevance: Useful for limited capacity in the wastewater collection network.	
			Non-Technical Measures:		Very possible to create standard procedure and schedule for regular monitoring and maintenance.
			4	Inflow and Infiltration (I/I) Monitoring and Maintenance Program	
				What: Routine CCTV inspection, smoke testing, and flow metering to locate and repair sources of infiltration.	
				Why: Preventive maintenance minimizes the cumulative effect of minor leaks.	
				Altona relevance: Early detection avoids chronic overloads during spring melt or storm events.	Within jurisdiction and should receive strong consideration.
			5	Public Education and Private Property Programs	
				What: Educate homeowners about disconnecting sump pumps and roof drains from the sanitary sewer; offer incentives or bylaw enforcement.	
				Why: Private connections are often a major inflow source.	
				Altona relevance: Many older homes may still direct foundation drains or sump discharges to the sewer.	Feasible but would need technical expertise to determine where to implement applications, this would be a new concept for the Town.
			6	Land Use and Stormwater Management Planning	
				What: Promote green infrastructure (e.g., rain gardens, permeable pavements) and restrict new development in flood-prone areas.	
				Why: Reduces stormwater entering the collection system and controls surface water at the source.	
				Altona relevance: Flat topography limits drainage; distributed infiltration and retention features help manage volumes locally.	

Systems	Climate Hazard	Comments	Adaptation Actions		Altona comments (e.g., applicability of the measure, jurisdictional responsibility, technical challenges, etc.)
Water supply and management systems*	DroHght	Water quality affect, extra treatment and costs	Technical Adaptation Measures:		
			7	Increase Local Water Storage Capacity	More technical analysis required, also needs to account for a minimum fire reserve and how long water is stored (turnover).
				What: Expand reservoir or elevated tank capacity to store several days of supply during peak heat demand or supply interruptions.	
				Why: Provides short-term resilience when regional sources are constrained.	
				Altona relevance: Offers buffer capacity during droughts or supply prioritization to industry.	
			8	Leak Detection and Pressure Management	Town is considering upgrading water meter technology that would assist with leak detection. Cost is prohibitive at this point in time.
				What: Implement active leak detection programs and smart pressure control systems.	
				Why: Reduces non-revenue water losses and extends the available supply.	
				Altona relevance: In small, aging networks, even modest losses can become critical during drought.	
			9	Water Reuse and Recycling for Non-Potable Applications	Has been implemented for municipal operations in the past during drought conditions. Some logistical issues to overcome regarding access to non-potable water source.
				What: Encourage or install greywater or reclaimed water systems for irrigation, industrial cooling, or dust suppression.	
				Why: Reduces potable water demand from industry and municipal operations.	
				Altona relevance: Could be integrated into industrial operations that already have water recycling capacity	
			Non-Technical Adaptation Measures:		
			10	Tiered Water Conservation and Drought Management Plan	Water conservation by-law already in place
				What: Refine the existing prioritization plan into tiered drought response stages (e.g., voluntary, mandatory, emergency), with clear triggers and communication protocols.	
				Why: Ensures transparent, predictable management of limited water.	
				Altona relevance: Builds trust and preparedness when industry must be prioritized.	
			11	Public and Industrial Water Efficiency Programs	Public awareness campaigns possible, to be coordinated with Pembina Valley Water Co-op
				What: Promote water-efficient appliances, xeriscaping, and industrial process audits. Offer rebates or recognition programs.	
				Why: Permanent demand reduction improves resilience without affecting service levels.	
				Altona relevance: Reduces strain during hot, dry summers when consumption peaks.	
			12	Regional Collaboration and Contingency Planning	Already completed
				What: Formalize agreements with neighboring municipalities and the Pembina Valley Water Co-op for emergency supply, sharing, or coordinated restrictions.	
				Why: Strengthens adaptive capacity beyond local control.	
				Altona relevance: Since the town doesn’t control its supply, coordination is critical for equitable allocation and planning future capacity increases.	
LOCAL ECONOMY					
Construction	Flooding	stops construction work	Technical Adaptation Measures		
			13	Elevated and Well-Drained Construction Sites	This is not really a major issue for us
				What: Use temporary berms, perimeter drainage ditches, or raised staging areas for materials and machinery.	
				Why: Keeps key equipment and materials above flood levels, allowing work to resume faster after rain events.	
				Altona relevance: Flat terrain means even shallow ponding can paralyze worksites; small elevation gains make a big difference.	

Systems	Climate Hazard	Comments	Adaptation Actions		Altona comments (e.g., applicability of the measure, jurisdictional responsibility, technical challenges, etc.)
			14	Improved Stormwater Management on Development Sites	This is not really a major issue for us
				What: Require contractors to include on-site stormwater management (temporary sumps, infiltration trenches, or sediment basins) in their construction plans.	
				Why: Reduces surface flooding and erosion within active projects.	
				Altona relevance: Helps maintain site accessibility during localized flooding.	
			15	All-Weather Access and Foundation Stabilization	This is not really a major issue for us
				What: Use geotextiles, gravel pads, or modular road mats for temporary access roads and staging areas.	
				Why: Allows limited construction activities to continue even when surrounding soils are saturated.	
				Altona relevance: Prevents vehicles from getting stuck in clayey, waterlogged ground.	
			Non-Technical Adaptation Measures		
			16	Revised Construction Scheduling and Contingency Planning	This is not really a major issue for us
				What: Integrate seasonal flood risk and soil saturation data into tender documents and project schedules.	
				Why: Anticipating likely flood windows reduces costly idle periods.	
				Altona relevance: Aligns construction with typically drier months and improves contractor preparedness.	
			17	Emergency Response and Communication Protocols for Construction Sites	This is not really a major issue for us
				What: Develop guidelines for securing materials, protecting excavations, and safe shutdown/restart after flood warnings.	
				Why: Minimizes damage and accelerates recovery.	
				Altona relevance: Helps smaller local contractors who may not have formal flood response procedures.	
			18	Insurance, Permitting, and Contract Clauses for Climate Delays	This is not really a major issue for us
				What: Include clauses for weather-related extensions, damage coverage, and shared risk allocation.	
				Why: Reduces financial burden and disputes when flooding disrupts timelines.	
				Altona relevance: Ensures local developers remain viable despite more frequent flood-related delays.	
Agriculture	Drought	crop reduction, when farmers do well, everyone does well, agri doesn't happen in town	Non-Technical / Governance Measures		
			19	Regional Collaboration and Advocacy	Could add Pembina Valley Watershed District to that list of organizations.
				What: Work with the RM of Rhineland, Pembina Valley Water Co-op , and agriculture organizations (e.g., Manitoba Agriculture, local producer groups) to plan for regional water management and drought response.	
				Why: Aligns urban and rural priorities (e.g., water allocation, emergency water trucking, drought monitoring).	
				Altona relevance: The town's economic stability depends on surrounding farms' productivity.	
			20	Economic Diversification and Local Business Support	Small grants and incentives possible but not feasible in a major way.
				What: Strengthen non-agricultural sectors (e.g., light manufacturing, services) and help agri-businesses adapt through drought-contingency grants or local incentives.	
				Why: Reduces the town's economic vulnerability to agricultural downturns.	
				Altona relevance: Supports employment and local spending even in poor crop years.	
			21	Community Awareness and Education	Beyond our scope, not many farmers within town boundaries. Could support initiative through Altona Rhineland Economic Development (economic development organization) if that Board supported it.
				What: Partner with agricultural extension services to host public workshops on water conservation, soil health, and climate adaptation in agriculture.	
				Why: Builds a shared understanding between town residents and rural producers.	
				Altona relevance: Encourages regional cooperation and public support for water restrictions during droughts.	

Systems	Climate Hazard	Comments	Adaptation Actions		Altona comments (e.g., applicability of the measure, jurisdictional responsibility, technical challenges, etc.)
			Technical / Infrastructure Support Measures		Not really affected locally by this factor but Pembina Valley Water Cooperative does on an annual basis. Expansion to their network is underway and additional capacity expected to become online in 2 years.
			22	Water Supply Resilience and Prioritization	
				What: Strengthen the town’s water storage and distribution systems to ensure it can sustain local residents and businesses during agricultural water stress periods.	
				Why: Prevents competition between municipal and farm needs from crippling the town’s supply.	
				Altona relevance: Agriculture can indirectly stress the shared water system.	
			23	Regional Drought Monitoring and Data Sharing	PVWC responsibility
				What: Collaborate with regional partners to share rainfall, soil moisture, and drought index data (e.g., through Manitoba Agriculture or the Prairie Climate Centre).	
				Why: Enables earlier response and coordinated messaging during droughts.	
				Altona relevance: Helps align municipal drought measures with agricultural realities.	
			24	Emergency Planning for Economic Impacts	Not currently included as a scenario
				What: Include agricultural drought scenarios in the town’s emergency or business continuity plans (e.g., loss of ag employment, transport disruptions, water trucking needs).	
				Why: Protects the town’s social and economic systems even if the drought occurs outside municipal boundaries.	
				Altona relevance: Keeps local services and supply chains functional when the regional economy slows down.	

Table E.2. Adaptation actions for high risks identified, based on the systems analyzed

Systems	Climate Hazard	Comments	Adaptation Actions		Altona comments (e.g., applicability of the measure, jurisdictional responsibility, technical challenges, etc.)
CRITICAL SERVICES					
Health care and Social Assistance	Flooding	Demand for services would increase	Technical Measures:		Not really an issue
			25	Flood Protection for Critical Facilities	
				What: Elevate or floodproof health care buildings, ambulance bays, and access roads; install sump pumps and backflow prevention.	
				Why: Ensures emergency services remain operational during localized flooding.	
				Altona relevance: The ER and main access routes could be isolated by overland flooding from Buffalo Creek or ponding.	
			27	Mobile or Remote Health Service Capacity	Good scenario to include in Emergency Plan and coordinate with their Emergency Coordinator
				What: Coordinate with Manitoba Health and regional partners for deployment of mobile clinics or telehealth services during access disruptions.	
				Why: Ensures continuity of care when residents or staff cannot travel safely.	
				Altona relevance: Could supplement local ER limitations and maintain care for vulnerable residents.	
			Non-Technical Adaptation Measures		Good responsibility for Local Emergency Response Control Group (or more specifically our Emergency Coordinator or Social Services Director)
			29	Vulnerable Population Registry	
				What: Maintain a confidential list of residents who need evacuation support, medical attention, or special assistance during floods.	
				Why: Enables targeted outreach and timely evacuation.	
				Altona relevance: Supports seniors and medically dependent residents during access disruptions.	

Systems	Climate Hazard	Comments	Adaptation Actions		Altona comments (e.g., applicability of the measure, jurisdictional responsibility, technical challenges, etc.)
Health care and Social Assistance	Drought	need for service increases, water treatment capacity	30	Community Volunteer and Mutual Aid Network	Good responsibility for Local Emergency Response Control Group (or more specifically our Emergency Coordinator or Social Services Director)
				What: Train and coordinate local volunteers to conduct wellness checks, deliver medication or food, and assist in shelters.	
				Why: Extends social support when formal systems are stretched.	
				Altona relevance: Strengthens community resilience and reduces burden on professional responders.	
			Technical Adaptation Measures		
			33	Cooling and Hydration Infrastructure	Public buildings already have air conditioning, additional shaded areas and water stations could be developed within existing budgets.
				What: Equip public buildings (e.g., community centre, library) with air conditioning, shaded areas, and water stations to serve as designated cooling centres.	
				Why: Provides safe, accessible spaces during prolonged heat waves.	
				Altona relevance: Critical for residents without home cooling systems, especially seniors and low-income households.	
			Non-Technical Adaptation Measures		
			35	Heat-Health Early Warning and Response Plan	Good responsibility for Local Emergency Response Control Group (or more specifically our Emergency Coordinator or Social Services Director)
				What: Establish a heat alert protocol with Manitoba Health, including communication triggers and response actions for local facilities and the public.	
				Why: Allows proactive outreach before health impacts escalate.	
				Altona relevance: Helps coordinate limited staff and volunteer resources efficiently.	
			36	Vulnerable Population Outreach Program	Good responsibility for Local Emergency Response Control Group (or more specifically our Emergency Coordinator or Social Services Director)
				What: Develop a call or visit system for seniors, isolated residents, and those without air conditioning during heat waves.	
				Why: Prevents heat illness and dehydration among at-risk groups.	
				Altona relevance: Builds on existing community networks for emergency wellness checks.	
			37	Public Awareness Campaigns	Good responsibility for Local Emergency Response Control Group (or more specifically our Emergency Coordinator or Social Services Director)
				What: Provide information on heat safety, hydration, and water conservation through town channels and social media.	
				Why: Encourages preventive action by residents before emergencies occur.	
				Altona relevance: Low-cost measure to reduce preventable ER visits.	
			39	Regional Collaboration on Health and Water Supply	Possible if/when led by PVWC or Southern Health
				What: Coordinate with Pembina Valley Water Co-op and regional health authorities to align community well-being and water shortage responses.	
				Why: Ensures continuity of care and fair water allocation during droughts.	
				Altona relevance: Critical since Altona depends on external water sources and shared infrastructure.	
Accommodation	Drought	cost and energy increases, homes are prepared for heat, hotel/motel may be affected (projects may be halted, restricted water use, cost of food)	Technical Adaptation Measures		
			40	Building Cooling Retrofits	Manitoba Hydro or Efficiency Manitoba currently have programs for this, could pass along messaging through social media
				What: Encourage installation of energy-efficient air conditioning, shading devices, reflective roofing, and improved insulation.	
				Why: Maintains indoor comfort during heat waves and reduces strain on municipal electricity supply.	
				Altona relevance: Homes and hospitality buildings without cooling are at higher risk of heat stress.	
			41	Water-Efficient Fixtures	Public awareness and/or incentive program could be coordinated with PVWC and the Town's water utility
				What: Promote low-flow taps, showers, dual-flush toilets, and smart irrigation for gardens.	
				Why: Reduces water demand, helping households and hotels comply with restrictions.	
				Altona relevance: Mitigates the impact of municipal water rationing during droughts.	

Systems	Climate Hazard	Comments	Adaptation Actions		Altona comments (e.g., applicability of the measure, jurisdictional responsibility, technical challenges, etc.)
			42	Energy-Efficient Appliances	Ongoing process as part of capital replacement program
				What: Upgrade HVAC, water heaters, and other appliances to high-efficiency models.	
				Why: Reduces energy costs during heat and drought periods.	
				Altona relevance: Helps households and small hotels cope with rising energy prices.	
			Non-Technical Adaptation Measures		
			43	Public Awareness on Water and Energy Use	Common messaging to be developed for all PVWC member municipalities
				What: Educate residents and business owners on water-saving practices, heat preparedness, and energy efficiency.	
				Why: Encourages voluntary demand reduction and helps manage peak loads.	
				Altona relevance: Low-cost, immediate mitigation measure.	
			44	Accommodation Operational Planning	Beyond Town's scope, could encourage this through awareness campaign with Altona & District Chamber of Commerce
				What: Encourage hotels/motels to integrate drought and heat considerations into business operations (e.g., staggered laundry, menu adjustments, water rationing).	
				Why: Reduces operational strain and maintains service quality.	
				Altona relevance: Ensures continuity of hospitality services during heat and drought events.	
			45	Incentives for Sustainable Building Practices	Possible on a smaller scale, Efficiency Manitoba may already have more generous programs available
				What: Provide financial, technical, or regulatory incentives for water and energy efficiency upgrades in homes and accommodations.	
				Why: Encourages proactive resilience measures without relying solely on regulation.	
				Altona relevance: Supports both economic and environmental sustainability.	
Food services	Drought	food supply affected only by extended periods, most of food supply from outside of Altona, likelihood of no water is low, water restrictions in place, local farmers markets would be affected, water quality issues in the past	Technical Adaptation Measures		
			46	Water-Efficient Kitchen Equipment	Could work with Altona & District Chamber of Commerce to raise awareness
				What: Promote low-flow dishwashers, faucets, and water recycling systems in restaurants.	
				Why: Reduces operational water use and maintains compliance during drought restrictions.	
				Altona relevance: Helps small food businesses stay open under limited water supply.	
			47	Backup Water Storage or Supply Agreements	Good scenario to include in Emergency Plan and coordinate with their Emergency Coordinator
				What: Establish agreements for emergency potable water deliveries or small on-site reserves.	
				Why: Ensures food safety and continuity of service during short-term supply interruptions.	
				Altona relevance: Supports resilience of restaurants and local markets during drought restrictions.	
			48	Enhanced Food Storage Infrastructure	Good scenario to include in Emergency Plan and coordinate with their Emergency Coordinator
				What: Improve refrigeration and dry storage to preserve food during supply disruptions.	
				Why: Reduces spoilage and dependency on daily deliveries.	
				Altona relevance: Important for local grocers and market vendors during transport delays.	
			Non-Technical Adaptation Measures		
			49	Local Food Sourcing and Partnerships	Could work with Altona Rhineland Economic Development and Altona & District Chamber of Commerce
				What: Strengthen links between local farmers, markets, and restaurants to shorten supply chains.	
				Why: Reduces reliance on distant supply chains vulnerable to regional drought.	
				Altona relevance: Supports local economic resilience.	

Systems	Climate Hazard	Comments	Adaptation Actions		Altona comments (e.g., applicability of the measure, jurisdictional responsibility, technical challenges, etc.)
			50	Water Conservation Guidelines for Food Services	Water conservation by-law guidelines could be expanded
				What: Develop voluntary guidelines for water use in commercial kitchens.	
				Why: Encourages proactive compliance with municipal restrictions.	
				Altona relevance: Reduces the need for enforcement during droughts.	
			51	Public Communication and Awareness	Could work with Altona & District Chamber of Commerce to raise awareness
				What: Inform residents of possible food cost fluctuations and promote local produce consumption.	
				Why: Encourages community support for local food systems.	
				Altona relevance: Mitigates public frustration and supports local farmers.	
INFRASTRUCTURE					
Stormwater network	Flooding	system can get overloaded, lack of elevation, very little maintenance after floods, surface drains get plugged with debris	Technical Adaptation Measures		
			52	Storm Drain Upgrades and Regular Maintenance	Public Works responsibility
				What: Increase inlet size, replace damaged culverts, and schedule annual inspections.	
				Why: Improves capacity and reliability during high-intensity rainfall.	
				Altona relevance: Flat terrain and aging stormwater assets make the system prone to overload during short, intense storms. Regular upgrades and maintenance reduce localized flooding and protect roads and properties.	
			53	Debris Management and Cleaning Program	Public Works staff currently has a procedure in place to monitor and clear drains during significant rainfalls
				What: Formalize a post-event SOP for rapid debris clearance from surface drains, ditches, and culverts; stage equipment and crews.	
				Why: Prevents blockages that exacerbate overland flooding and prolong recovery.	
				Altona relevance: After heavy rain, surface drains often clog with gravel, leaves, and litter; rapid, standardized clean-ups reduce repeat flooding in low-lying neighbourhoods and along key access routes.	
			54	Green Infrastructure for Runoff Management	Feasible but would need technical expertise to determine where to implement applications, this would be a new concept for the Town.
				What: Install bioswales, rain gardens, and permeable surfaces at runoff pinch points and red-zone depressions; protect natural storage “green sinks.”	
				Why: Increases infiltration and reduces stormwater load on infrastructure.	
				Altona relevance: Distributed, nature-based storage is well-suited to Altona’s flat topography and clayey soils, reducing street ponding and complementing limited pipe capacity.	
			55	Digital Asset and Maintenance Mapping	Some stormwater assets geo-located in GIS inventory, cleaning schedules not established.
				What: Complete GIS inventory of stormwater assets and link to cleaning/inspection schedules and condition ratings.	
				Why: Improves monitoring, prioritization, and accountability for O&M and capital planning.	
				Altona relevance: With partial GIS coverage today, a full, schedule-linked inventory helps Public Works target the most flood-prone segments and demonstrate value-for-money in upkeep.	
			Non-Technical Adaptation Measures		
			56	Post-Flood Maintenance Policy	Standard operating procedures not documented
				What: Formalize procedures for rapid assessment and cleaning after storm events.	
				Why: Ensures consistent recovery and reduces system degradation.	
				Altona relevance: A clear SOP helps small teams mobilize quickly across town, minimizing service disruptions residents feel most acutely after storms.	

Systems	Climate Hazard	Comments	Adaptation Actions		Altona comments (e.g., applicability of the measure, jurisdictional responsibility, technical challenges, etc.)
Recreation centres	Drought	more pool visitors, more watering of flowers, grass, increase AC, limited to opening hours of rec centre	57	Public Awareness Campaign	Communications responsibility
				What: Communications campaign and bylaw reminders to prevent dumping (yard waste, gravel, snow) into surface drains.	
				Why: Reduces clogging, lowers maintenance burden, and preserves conveyance capacity.	
				Altona relevance: Community habits directly affect drain performance; simple messaging reduces blockage hotspots and repetitive call-outs.	
			58	Stormwater Master Plan Update	Public Works responsibility
				What: Review hydraulic capacity and climate projections to guide upgrades.	
				Why: Ensures infrastructure remains adequate for future flood risks.	
				Altona relevance: Ensures scarce capital dollars target the worst bottlenecks first, reflecting community priorities around visible flood mitigation.	
Recreation centres	Drought	more pool visitors, more watering of flowers, grass, increase AC, limited to opening hours of rec centre	Technical Adaptation Measures		
			59	Energy-Efficient Cooling Systems	Could be implemented within Asset Management Plan and asset replacement schedule/strategy
				What: Upgrade HVAC and use programmable thermostats.	
				Why: Reduces energy costs and maintains comfort during peak use.	
				Altona relevance: Recreation centres act as informal cooling spaces; efficient systems lower operating costs and keep facilities reliable during heat events.	
			60	Water Recycling for Landscaping	Has been implemented for municipal operations in the past during drought conditions. Some logistical issues to overcome regarding access to non-potable water source.
				What: Use greywater or stormwater collection for irrigation.	
				Why: Cuts potable demand and maintains green spaces under drought restrictions.	
				Altona relevance: Past drought operations showed feasibility; expanding reuse buffers landscaping needs when PVWC supply is tight.	
			61	Shade Structures and Reflective Surfaces	Could be implemented within Asset Management Plan and asset replacement schedule/strategy
				What: Install shade canopies and reflective materials on roofs.	
				Why: Lowers heat gain and provides comfort for outdoor users.	
				Altona relevance: Shaded, cooler facilities support families and seniors during heat waves, aligning with community well-being goals.	
			Non-Technical Adaptation Measures		
			62	Modified Operating Hours	Good scenario to include in Emergency Plan and coordinate with the Emergency Coordinator
				What: Extend opening hours during extreme heat events.	
				Why: Offers safe, accessible relief during peak heat.	
				Altona relevance: Flexible hours help residents without home A/C and reduce heat-related health risks.	
			63	Water Conservation Programming	Water conservation by-law guidelines already in place
				What: Staff/user guidance to cut non-essential water use in facilities and grounds.	
				Why: Supports drought restrictions and reduces costs.	
				Altona relevance: Reinforces town-wide conservation messages and eases pressure on shared regional supply.	
			64	Public Communication on Cooling Access	Communications responsibility
				What: Promote recreation facilities as designated cooling spaces. Promote designated cooling/clean-air spaces and hours via town channels.	

Systems	Climate Hazard	Comments	Adaptation Actions		Altona comments (e.g., applicability of the measure, jurisdictional responsibility, technical challenges, etc.)
				Why: Ensures residents know where to seek relief during heat waves or when smoke persists.	
				Altona relevance: Clear, practical information aligns with community preference for hazard-focused messaging.	
			65	Event Scheduling Adjustments	Research guidelines from Health Canada or Manitoba Public Health
				What: Shift outdoor events to cooler hours; apply heat-safety guidelines.	
				Why: Reduces health risks for participants.	
				Altona relevance: Supports sports and community events while protecting vulnerable groups during hotter summers.	
LOCAL ECONOMY					
Arts, entertainment and recreation	Flooding	Limit sporting events	Technical Adaptation Measures		
			67	Improved Drainage at Event Sites	Feasible but would need technical expertise to determine where to implement applications, this would be a new concept for the Town.
				What: Install subsurface drainage and use permeable materials in high-traffic areas.	
				Why: Allows faster drying and earlier reopening after floods.	
				Altona relevance: Reduces cancellations and preserves community programming despite frequent heavy showers.	
			68	Backup Power and Communication	Good scenario to include in Emergency Plan and coordinate with the Emergency Coordinator, if deemed appropriate use of assets
				What: Provide mobile generators and emergency communication for major venues.	
				Why: Enables safe coordination during flood events.	
				Altona relevance: Supports continuity of community gatherings and emergency messaging when weather disrupts power.	
			Non-Technical Adaptation Measures		
			69	Flexible Scheduling and Contingency Planning	Recreation Services responsibility
				What: Build in alternate dates and venues for key community events.	
				Why: Reduces cancellations and supports community morale.	
				Altona relevance: Practical planning keeps morale high and reduces strain on recreation services after storms.	
			70	Insurance and Emergency Funding	Recreation Services responsibility
				What: Encourage event interruption coverage and access to emergency funds.	
				Why: Reduces financial losses.	
				Altona relevance: Small organizers benefit from financial resilience when severe weather disrupts operations.	

Table E.3. Adaptation actions for moderate risks identified, based on the systems analyzed

Systems	Moderate Risk	Comments	Adaptation Actions		Altona comments (e.g., applicability of the measure, jurisdictional responsibility, technical challenges, etc.)
CRITICAL SERVICES					
Educational Services	Drought	plumbing and hygiene, use of sanitizer, A/C equipped	Non-Technical Adaptation Measures		Could assist with delivering message in coordination with PVWC and Border Land School Division (BLSD)
			74	Water Conservation Awareness Programs	
				What: Conduct education campaigns on water use reduction in schools.	
				Why: Encourages responsible habits and lowers overall water consumption.	
		Altona relevance: Education supports town-wide drought tiers and aligns with limited regional supply.			
Transportation and Warehousing	Drought	for small populations, no access to vehicles, testing affordable transportation models/options	Technical Adaptation Measures		
			83	Shared and Electric Transportation Options	
				What: Develop community car-sharing or electric shuttle systems.	
				Why: Reduces dependence on private vehicles and supports mobility during fuel or heat stress.	
				Altona relevance: Affordable access benefits residents without vehicles and provides cooler, shaded alternatives in heat events.	
			84	Shaded Active Transport Routes	
				What: Plant shade trees and add shelters along bike/ped corridors.	
				Why: Makes active transport safer and comfortable during heat.	
				Altona relevance: Integrates with Urban Forest and active transportation (AT) plans; reduces heat stress and supports low-emission travel.	
			85	Heat-Resilient Vehicle Systems	
				What: Ensure fleets and fuel systems are adapted for high temperatures.	
				Why: Reduces service interruptions and mechanical failures during drought-related heat.	
				Altona relevance: Keeps essential services (roads, utility checks) operating in hotter summers.	
			Non-Technical Adaptation Measures		
			86	Affordable Mobility Partnerships	
				What: Collaborate on regional transit/carpool networks; community pilots.	
				Why: Improves accessibility for residents without vehicles.	
				Altona relevance: Supports equity during heat events and complements local AT initiatives.	
			87	Transportation Support Programs	
				What: Provide mobility assistance for vulnerable populations during heat events.	
				Why: Maintains equitable access to essential services.	
				Altona relevance: Targets seniors/low-resource households consistent with community well-being priorities.	
			88	Active Transportation Promotion	
				What: Encourage walking and cycling through community programs.	
				Why: Reduces emissions and supports community well-being.	
				Altona relevance: Encourages local trips on shaded routes, lowering exposure to heat and supporting family budgets.	

Systems	Moderate Risk	Comments	Adaptation Actions			Altona comments (e.g., applicability of the measure, jurisdictional responsibility, technical challenges, etc.)
Waste Management (collection and disposal)	Drought	poor disposal and fire issues/hazards (i.e. battery disposal), heat and drought multiply the hazards, heat exhaustion of employees	Technical Adaptation Measures			
			89	Fire Suppression and Shaded Storage Areas		Could work within Town's Asset Management Plan and asset replacement plan/strategy
				What: Install suppression systems and shade structures where combustible materials are stored.		
				Why: Lowers ignition risk and protects workers during heat.		
				Altona relevance: Hot, dry spells elevate fire hazards; shading and suppression reduce incidents and service interruptions.		
			90	Heat-Resistant Waste Containers		Not really an issue, yet!
				What: Use metal or insulated waste bins in high-risk areas.		
				Why: Reduces risk of ignition and odour buildup.		
				Altona relevance: Proportionate, preventative measure where plastics deform or trap heat; deploy selectively as heat days increase.		
			91	Improved Ventilation in Facilities		Not really an issue
				What: Upgrade ventilation in sorting/storage areas.		
				Why: Protects workers from heat and fumes.		
				Altona relevance: Protects staff during sustained heat waves; supports contractor safety performance.		
			Non-Technical Adaptation Measures			
			92	Worker Heat Safety Training		Safety Coordinator responsibility
				What: Train staff on heat exhaustion prevention and safe waste handling.		
				Why: Reduces workplace accidents and health risks.		
				Altona relevance: A practical, low-cost step for contracted and municipal crews working outdoors in higher temperatures.		
			93	Adjusted Collection Schedules		Waste collection services contracted out
				What: Move collection hours to early morning or evening.		
				Why: Protects employees from peak heat exposure.		
				Altona relevance: Aligns operations with heat advisories; minimal disruption to service users.		
			94	Public Disposal Campaigns		Communications responsibility
				What: Run public education on safe battery and hazardous waste disposal.		
				Why: Reduces fire hazards and contamination during hot, dry conditions.		
Altona relevance: Simple behaviour changes reduce costly, dangerous incidents during hot, dry conditions.						
INFRASTRUCTURE						
Buildings (Residential, commercial and Institutional)	Flooding	water in basements, flooding 20-25 homes	Technical Adaptation Measures			
			95	Sump Pumps and Backflow Preventers		Small incentive program previously offered in the 1990s in conjunction with provincial funding, could be revived through Town's water/sewer utility
				What: Incentives/guidance for installing sump pumps and sewer backflow valves in at-risk houses.		
				Why: Reduces basement flooding and water damage.		
				Altona relevance: Targets the ~20–25 frequently affected homes and reduces repeat claims and emergency call-outs.		

Systems	Moderate Risk	Comments	Adaptation Actions		Altona comments (e.g., applicability of the measure, jurisdictional responsibility, technical challenges, etc.)
			Non-Technical Adaptation Measures		
			98	Floodproofing Education	Communications responsibility
				What: Provide residents with information and incentives for home floodproofing.	
				Why: Increases household resilience and reduces municipal recovery costs.	
				Altona relevance: Practical tips (grading, window wells, backflow) resonate with residents and produce visible benefits.	
			99	Rapid Assessment and Cleanup Plans	Good scenario to include in Emergency Plan and coordinate with their Emergency Coordinator
				What: Develop post-flood inspection and cleanup procedures, including standard checklists for inspections, safe re-entry, and debris removal.	
				Why: Enables faster recovery and safer reoccupation.	
				Altona relevance: Clear procedures and communications reduce confusion and keep neighbourhoods functioning after storms.	
			100	Registry of Flood-Prone Homes	Good database for Local Emergency Response Control Group to maintain (Emergency Coordinator)
				What: Maintain a confidential list of frequently affected properties to prioritize support.	
				Why: Focuses resources and enables targeted outreach.	
				Altona relevance: Helps coordinate incentives, inspections, and communications where they're most needed.	
Roads and associated structures	Flooding	gravel roads affected, asphalt damage	Technical Adaptation Measures		
			101	Upgraded Drainage and Culverts	Part of our drainage budget but not documented or formalized
				What: Increase ditch capacity and culvert sizing; harden outlets against erosion.	
				Why: Prevents road washouts and extends pavement life during major rain.	
				Altona relevance: Protects critical access routes and reduces maintenance backlogs after floods.	
			102	Flood-Resilient Pavement Materials	Limited exposure but may be useful in certain areas (9th Street NW, 9th Street SW)
				What: Use polymer-modified asphalt or reinforced gravel in flood-prone segments.	
				Why: Enhances road durability under prolonged wet conditions.	
				Altona relevance: Targeted material upgrades reduce rutting and pothole formation in known trouble spots	
			103	Elevation of Critical Routes	9th Street NW being raised in 2026
				What: Raise or reinforce main access roads in flood-prone zones.	
				Why: Maintains emergency and service access during floods.	
				Altona relevance: With 9th Street NW already scheduled, this approach demonstrably reduces overland flow impacts on mobility.	
			Non-Technical Adaptation Measures		
			104	Post-Flood Maintenance Planning	Good scenario to include in Emergency Plan and coordinate with their Emergency Coordinator
				What: Establish rapid inspection and repair protocols after flood events.	
				Why: Restores connectivity and prevents long-term damage.	
				Altona relevance: Ensures crews address the most-used routes first and reduces complaints/service delays.	

Systems	Moderate Risk	Comments	Adaptation Actions		Altona comments (e.g., applicability of the measure, jurisdictional responsibility, technical challenges, etc.)
			105	Mapping Critical Access Routes	Good scenario to include in Emergency Plan and coordinate with their Emergency Coordinator
				What: Identify and prioritize key emergency and service routes with detours.	
				Why: Ensures continuity of essential transportation during flooding by guiding operational decisions during road closures.	
				Altona relevance: Provides clarity for residents and responders when localized flooding cuts normal travel paths.	
			106	Integration of Flood Risk in Planning	Yes!
				What: Embed flood maps and event history into capital planning and design standards.	
				Why: Directs investment to high-risk segments and improves lifecycle performance.	
				Altona relevance: Ensures road projects reflect local flow paths and ponding realities identified in town analyses.	
Electricity distribution	Gusty winds	power outages, branches falling, localized effects, lots of overhead lines	Technical Adaptation Measures		
			108	Underground Power Line Installation	Cost prohibitive, require new developments to develop this way
				What: Bury lines in select high-risk corridors; require undergrounding in new developments.	
				Why: Reduces outages from gust winds/tornadoes and tree/branch strikes.	
				Altona relevance: Broad undergrounding is cost-prohibitive; a targeted approach protects critical feeders while keeping budgets realistic.	

Table E.4. Other Adaptation Actions

Systems	Climate Hazard	Comments	Adaptation Actions	
Multiple	Multiple	General measures that impact the town's adaptation capabilities across multiple climate hazards	Technical Measures:	
			113	Council & Staff Training on Hazard Literacy, Emergency Playbooks, and Climate Lens in Procurement/Asset Management
				What: Deliver structured training sessions for council members and senior staff on hazard-specific preparedness (floods, heat, smoke, blizzards), emergency response protocols, and integrating a climate lens into procurement and asset management decisions.
				Why: Builds institutional capacity to make informed, proactive decisions that reduce risk, ensure service continuity, and embed resilience into long-term planning and budgeting.
				Altona Relevance: The Town's operational capacity is limited; embedding hazard awareness and resilience thinking at the governance level ensures that adaptation measures are prioritized and funded consistently, rather than treated as ad hoc responses.
			Non-Technical Adaptation Measures	
			114	Urban Canopy Strategy to Shade Streets/Schools & Heat-Risk Blocks First; Integrate with Active Transportation Routes
				What: Develop and implement a municipal strategy to expand tree canopy coverage in priority areas (schools, pedestrian corridors, heat-risk neighborhoods), coordinated with the Active Transportation Master Plan.
				Why: Trees provide multiple co-benefits: reduce urban heat island effects, improve stormwater infiltration, enhance livability, and support active transportation by making routes safer and more comfortable during heat waves.
				Altona Relevance: Extreme heat is projected to increase significantly, and many residents lack home cooling. Shaded routes and public spaces reduce heat stress for vulnerable populations and encourage safe, low-emission mobility options, aligning with community priorities for health and sustainability.

F. EXTRAPOLATION OF DESIGN RAINFALL TO THE 200-YEAR RETURN PERIOD

F.1. Purpose and Data Sources

This appendix documents the methodology used to extrapolate short-duration design rainfall to the 200-year return period for municipal drainage and flood-risk assessment purposes. The analysis is based on projected Intensity–Duration–Frequency (IDF) values for Altona, Manitoba, obtained from ClimateData.ca. These IDF values are based on the Shared Socio-economic Pathways (SSPs) used in the Coupled Model Intercomparison Project Phase 6 (CMIP6), specifically SSP5-8.5, which represent statistically derived rainfall depths and do not constitute raw annual maximum rainfall observations. This SSP was selected for conservativeness reasons, as it reflects a future where economic growth and fossil fuel use are prioritized over sustainability, resulting in extreme climate change impacts.

As raw station data were not available for direct frequency analysis, extrapolation beyond the published return periods was undertaken using accepted extreme-value methods applied to the available IDF quantiles. For this exercise, the 90th quantiles values were used, which are expected to best reflect extreme events, and the rainfall analyzed was the 1 hour rainfall event.

F.2. Distribution Selection for Design Extrapolation

Extreme rainfall extrapolation is commonly performed using the Generalized Extreme Value (GEV) distribution. The GEV distribution includes a shape parameter (ξ) that controls upper-tail behaviour and allows representation of both bounded and heavy-tailed extremes. The Gumbel distribution is a special case of the GEV distribution corresponding to a zero shape parameter ($\xi = 0$).

GEV parameters were evaluated using standard hydrologic fitting approaches applied to the available IDF values. The estimated shape parameter was consistently found to be very close to zero ($|\xi| \approx 0.01\text{--}0.02$) and sensitive to the fitting method. This sensitivity reflects:

- the limited number of available data points per duration,
- the use of pre-modelled IDF quantiles rather than observed annual maxima, and
- the characteristics of short-duration Prairie rainfall.

When the fitted shape parameter is near zero, the GEV distribution effectively reduces to the Gumbel distribution, and attempts to estimate ξ add uncertainty without materially improving representation of extreme rainfall behaviour.

F.3. Prairie and Municipal Hydrology Considerations

Short-duration extreme rainfall in southern Manitoba is primarily associated with convective storm systems. These events typically exhibit limited tail curvature at hourly and sub-hourly durations due to physical constraints on storm intensity and duration. Consistent with Prairie hydrologic practice, fitted extreme-value distributions for short durations often yield shape parameters that are small and statistically indistinguishable from zero.

For municipal engineering applications—where design robustness, transparency, and reproducibility are priorities—the use of a Gumbel formulation for short-duration rainfall is common, particularly when extrapolating beyond the return periods explicitly provided in published IDF tables.

F.4. Extrapolation to the 200-Year Design Event

Extrapolation to the 200-year return period was carried out using a Gumbel distribution fitted to the available IDF values. The Gumbel formulation provides a stable and conservative basis for extrapolation while avoiding over-interpretation of tail behaviour that cannot be reliably inferred from the available data.

To assess sensitivity, 200-year rainfall depths were also computed using GEV distributions with fitted shape parameters slightly above and below zero. Differences between Gumbel- and GEV-based estimates were modest and within the expected uncertainty range for extreme rainfall extrapolation. This confirms that the selected approach does not materially understate design rainfall while maintaining numerical stability.

Accordingly, the Gumbel-based 200-year rainfall estimate was adopted as the primary design value for municipal assessment, with GEV results retained for sensitivity comparison.

F.5. Design Interpretation and Limitations

The 200-year rainfall value represents a planning and design benchmark for evaluating flood risk and infrastructure resilience. As with all extreme-value extrapolation beyond observed or published data ranges, uncertainty increases with return period. The adopted methodology prioritizes consistency with Prairie municipal practice and avoids false precision associated with fitting highly sensitive tail parameters.

F.6. Professional Disclaimer

This analysis has been prepared for planning and informational purposes only and does not constitute engineering advice. The rainfall estimates and extrapolations presented herein are intended to support high-level municipal flood risk and climate adaptation assessments and are not suitable for detailed engineering design or construction without review and application by a licensed professional engineer. Final design decisions should be undertaken by qualified engineering professionals in accordance with applicable standards and regulatory requirements.

F.7. Calculation and Results

Below we describe the methodology used to extrapolate the depth in mm of a 1 hour, 200 years rainfall event:

F.7.1. Data Provided

T (yr)	Depth (mm)
2	45
5	55
10	62
25	71
50	77
100	84

Where:

T: Return period in years

Depth: 1-hour rainfall depth in millimetres for the 90th-percentile series (P90)

F.7.2. Plotting Position & Reduced Variate

Calculate the following :

$$F = 1 - \frac{1}{T}$$
$$-\ln(F)$$
$$z = \ln(-\ln(F))$$

Where :

F: Non-exceedance probability

z: Gumbel reduced variate

F.7.3. Centering for Least-Squares Regression

Calculate the following:

- z_{bar} : Mean (average) of all z values.
- x_{bar} : Mean (average) of Depth values.
- $(z - z_{\text{bar}})$
- $(\text{Depth} - x_{\text{bar}})$
- $(z - z_{\text{bar}}) * (\text{Depth} - x_{\text{bar}})$
- $(z - z_{\text{bar}})^2$

F.7.4. Linear Fit in the Reduced Variate

Calculate the following:

$$m = \frac{(z - z_{\text{bar}}) * (\text{Depth} - x_{\text{bar}})}{(z - z_{\text{bar}})^2}$$
$$a = x_{\text{bar}} - mz_{\text{bar}}$$
$$\mu = a$$
$$\beta = -m$$

Where:

m: Regression slope

a: Regression intercept

μ and β : Gumbel (EV1) parameters

F.7.5 Extrapolation to the 200-year Event

Calculate as:

$$x_{200} = \mu + mz_{200}$$

Where:

x200: Extrapolated 1-hour rainfall depth (mm) for the 200-year event

z200: Reduced variate at T = 200 years

F.7.6. Results

The results from applying the methodology described above are shown below:

T (yr)	Depth (mm)	F	-ln(F)	z = ln(-ln(F))	z - zbar	Depth - xbar	(z - zbar)* (Depth - xbar)	(z - zbar)^2
2	45	0.5	0.69315	-0.36651	2.26973	-20.66667	-46.90770	5.15166
5	55	0.8	0.22314	-1.49994	1.13630	-10.66667	-12.12054	1.29118
10	62	0.9	0.10536	-2.25037	0.38587	-3.66667	-1.41487	0.14890
25	71	0.96	0.04082	-3.19853	-0.56229	5.33333	-2.99890	0.31617
50	77	0.98	0.02020	-3.90194	-1.26570	11.33333	-14.34458	1.60199
100	84	0.99	0.01005	-4.60015	-1.96391	18.33333	-36.00500	3.85694
							-113.79158	12.36684

zbar	xbar	sum_prod	sum_sq	m	a	mu	beta	F200	z200	x200
-2.63624	65.66667	113.79158	12.36684	-9.20134	41.40971	41.40971	9.20134	0.995	-5.29581	90.1383

The depth calculated for a 1 hour, 200 years rainfall event is 90.1383 mm. For the flood analysis presented in the body of this report we used 91 mm.

F.8 Summary

- Projected IDF values were used to estimate the 1 hour, 200 years rainfall event, resulting in a depth of 90.1383. For this report, a depth of 91 mm was used.
- GEV distributions were evaluated, but the fitted shape parameter was near zero and unstable.

Given Prairie rainfall characteristics and data limitations, a Gumbel distribution was selected for primary extrapolation to the 200-year event.