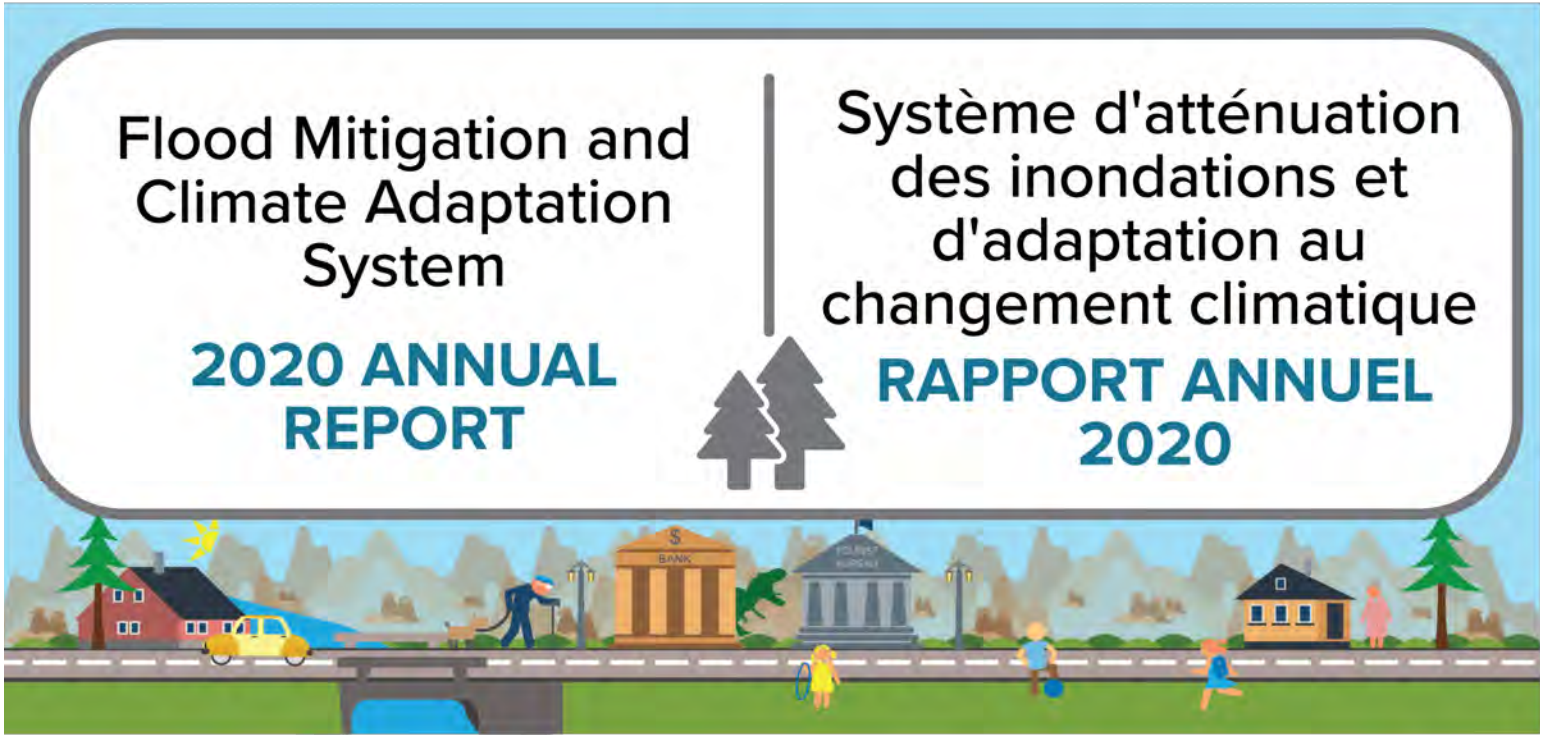
DRUMHELLER FLOOD MITIGATION and CLIMATE ADAPTATION SYSTEM
Changing the Channel of Flood Readiness

Canada

DRUMHELLER VALLEY

Alberta
Freedom To Create. Spirit To Achieve.



DRUMHELLER VALLEY

Drumheller Flood Mitigation and Climate Adaptation System: Changing the channel on flood readiness

WHO:	Town of Drumheller
WHAT:	Flood Mitigation and Climate Adaptation System
WHERE:	100 kilometres of riverbank in the community of Drumheller
WHEN:	2019 - 2024
HOW:	Drumheller Resiliency and Flood Mitigation Office
HOW MUCH:	Funding total: $55M

Overview

In March 2019, the Government of Canada committed funding in the amount of $22M to Drumheller's Flood Mitigation and Climate Adaptation System through the Government of Canada's Disaster Mitigation and Adaptation Fund (DMAF). The Government of Alberta also committed $28M in funding to this project through the Alberta Community Resiliency Program (ACRP). With the additional municipal investment of $5M, a total of $55M has been dedicated to the Drumheller Flood Mitigation and Climate Adaptation System to change the channel on flood readiness in the community.

LEVERAGE. INTEGRATE. LEGACY.

We are committed to leveraging opportunities, integrating approaches to flood mitigation and building a legacy in a proactive and sustainable way. This will form the basis of a 3-word community 'Pledge' for the program.

Mayor Heather Colberg and Chief Resiliency and Flood Mitigation Officer, Darwin Durnie, announce confirmed federal grant funding for the Drumheller Flood Mitigation and Climate Adaptation System.

WE'RE CHANGING THE CHANNEL ON FLOOD READINESS!

DRUMHELLER.CA

@drumhellerALERT

Drumheller Resiliency and Flood Mitigation Office

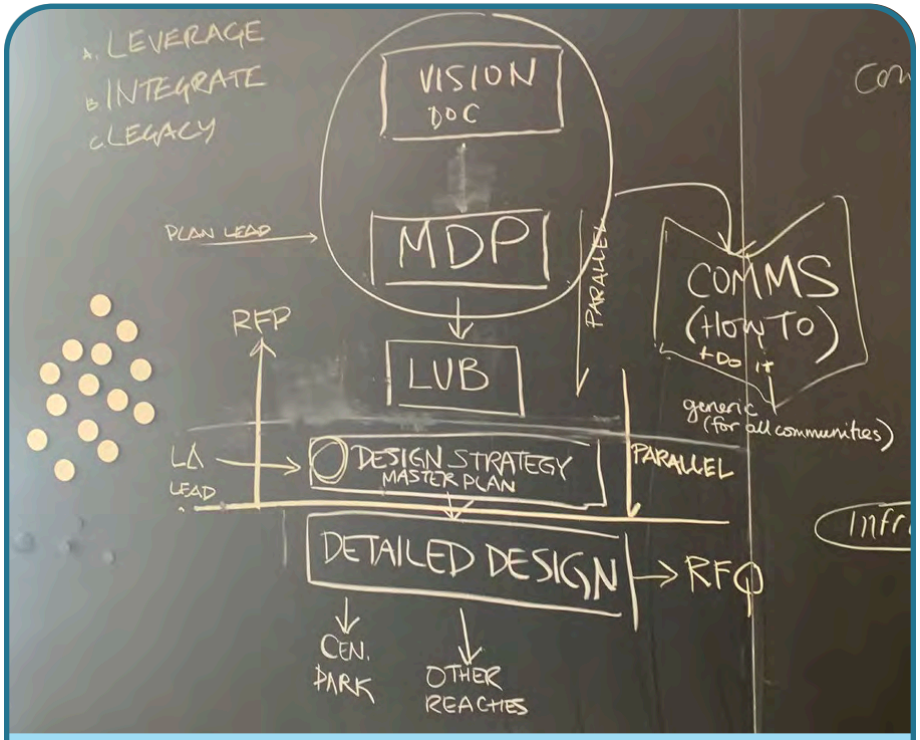
The purpose of this office is to protect the people and property in Drumheller from loss due to flooding through a sensible model for a small community to adapt to the perils of changing climate. The Resiliency and Flood Mitigation Office will manage the Flood Mitigation and Climate Adaptation Plan through to its completion in 2024.
Mission: Protect residents and property from loss or injury related to the perils of flood and changes in climate.
Goal: Preserve the value of property and ensure risk is reduced to levels which allows financial and insurance products to remain available.
Aim: Implement a comprehensive mitigation program for flooding and adaptation to changes in climate by 2025 with the following objectives:

1. Communication and public engagement
2. Regulatory/approvals
3. Conveyance capacity
4. Structural measures
5. Municipal Emergency Plan (MEP)

Council took a bold step in hiring an expert team of seasoned practitioners that have been through flood, fires and major community disasters to help manage the project and address the concerns of the community. For the first time in our community, a Chief Resiliency and Flood Mitigation Officer was hired to lead this team and ensure that Drumheller is flood ready and that resident concerns are addressed pre-flood, during a flood and post-flood.
The creation of the Resiliency and Flood Mitigation Office will follow the principles of the internationally recognized Incident Command System (ICS).

January – December 2020

This report is intended to provide governing bodies and key stakeholders an overview of the current and planned objectives for the Drumheller Resiliency and Flood Mitigation Office. While the COVID-19 global pandemic created unforeseen hurdles, the project has been able to prevail and make excellent headway throughout the year. We were able to secure all the funding required for the project, begin land acquisitions, complete geotechnical and terrestrial studies, complete necessary dike inspections, complete indigenous consultation site visits, modernize key municipal planning documents, make headway on the flood emergency response manual, and break ground on System 2100 starting with Clark Hill to Hoodoos.



Planning day, February 2020

Communications and Engagement

Creating and implementing a communication plan and an inclusive public engagement and stakeholder strategy is a critical part of this initiative. The need to work with the community, businesses and residents, to take on ownership and responsibility in helping change the channel on flood readiness in Drumheller is very important. The following communications activities and stakeholder engagement occurred from January – December 2020:

- Indigenous consultation and engagement:
  - » Stoney Nakoda Nation – correspondence with no return answer (January 30)
  - » Siksika First Nation meeting to confirm project details and desire to meet in spring to conduct ceremony prior to traditional use study (February 3) – postponed due to COVID-19
  - » Blood Tribe – meeting at Grey Eagles Resort to provide overview of program. Interest in historical resource and archaeological findings in prescribed area. Will schedule site visit in mid spring (February 10) – postponed due to COVID-19
  - » Tsuut'ina First Nation – meeting at tribal office. Provided overview of program interested in ceremony in advance of work commencing. Will schedule meeting in mid Spring (February 10) – postponed due to COVID-19
  - » Siksika Nation Council meeting with Mayor Colberg – interest in joint council meeting and exploring opportunities to develop long term relationship (March 5)
  - » Received positive feedback from Infrastructure Canada that they are satisfied and pleased with approach to consultation and engagement town has adopted in regards to Indigenous Consultation process to date (March 10)
  - » Application sent to Alberta Consultation Office (ACO). Response received was a Level 1 streamlined consultation with 7 First Nations

Mayor Colberg attends Siksika Nation Council meeting, March 2020

  - » 2 band site visits requested and completed (Siksika and Blood First Nations)
  - » Consultation Logs have been forwarded to the 7 bands for them to review
  - » We are hoping to receive an Adequacy decision from the ACO early in 2021
  - » Consultation Office for adequacy in early January 2021
- Crisis Communications training held for Town staff and council
- Produced videos highlighting updates and educating citizens of the Valley on the flood mitigation project and emergency preparedness:
  - » Urban Tree Strategy (June 26)
  - » Storm Detention Ponds (July 2)
  - » Newcastle Recreation Area (July 28)
  - » Flood Wall History (July 30)
  - » Grant Funding Announcement (Aug. 12) – DFAM sign installation
  - » Focus on the new MDP and LUB and how they help with flood mitigation (Aug. 13)
  - » Berm Design (Sept. 9)
  - » Focus on the steps to become more adaptive, explaining

the new zones, strategies and why flood mitigation in the Drumheller Valley is so important (Sept. 17)
  - » Dike Condition Inspection (Sept. 23)
  - » Clark Hill to Hoodoo Project Sign Unveiling (Oct. 2) – DFAM sign installation
  - » Understanding Tree and Rodent Impact on Berms (Sept. 30)
- Launched dedicated Flood Readiness Website (February 5)
- Implementing public education campaign based on themes: Be Informed. Plan Ahead. Take Action – over 500 social media posts across Facebook, Instagram and Twitter
  - » Instagram page launched September 2020
- Developed educational opportunities to be delivered to Grade 4 students canceled due to COVID-19 school closures
- Project updates highlighted on dedicated Flood Readiness website:
  - » Land Acquisition Policy (Jan. 20)
  - » Website Launch (Feb. 5)
  - » Family Day Activities (Feb. 18)
  - » Flood Mitigation Maintenance Updates (March 4)
  - » Flood Season Reminder (May 15)
  - » River Updates (May 25, June 1)
  - » Flood Mitigation Surveying (June 9)
  - » Urban Forest Surveying (June 10)
  - » Land Acquisition Process (July 17)
  - » Dike Condition Inspections (Sept. 17)
  - » Bore Hole Drilling (Oct. 5)
  - » Land Use Webmap Launch with Palliser Regional Municipal Services (Nov. 10)
  - » “What We Heard Report” now available (Nov. 27)
  - » MDP/LUB Passes at Town Council (Dec. 8)
- Adopting Land Acquisition Policy and Process
- Engaging with affected homeowners impacted by Land Acquisition
- Flood Forum with other DMAF recipients and academia planned for April 19-22 to show leadership and provide an opportunity for municipalities and experts to share best practices in mitigating flooding disasters – postponed due to COVID-19
- Held two mitigation system inspections/orientations
- Held meeting with local contractors to review flood mitigation project opportunities
- Held meeting with local Realtors to discuss land acquisition policy and process
- Developed phone scripts for town staff to assist in answering frequently asked questions
- Five flood advisory committee meetings were held to provide status updates
- Twenty-five weekly team meetings conducted to coordinate activities and consolidate communications
- Meeting with Palliser Regional Municipal Services in Hanna
- Five planning technical meetings with O2 Design as it relates to Master Engineering Design and Assessment of Planning Impacts
- Coordination of communication strategies with O2 Design
- Communications discussing the 8-steps to changing the channel
  - » Local Newspaper (Drumheller Mail) two-page spread (Sept. 16)
  - » Social media campaign (September - December)
- Information brochures explaining the DRFMO (Aug. 26)
- Local farmers market participating with flood mascot (Sept. 19)
- Regular radio and newspaper

Drumheller Farmer’s Market, September 2020

advertising as required

- Launched “On the Trail with Morris the Hike-Asaurus” in September
  - » Frequent “blog” hosted on website and in the Drumheller Mail from the perspective of the flood mascot, provides updates in a friendly manner and addresses any misconceptions around the program
- Land Assembly information packages completed for Sept. 14
- Internal technical meetings with staff to understand impacts of new policies (ongoing)
- Regular website updates
- Rotary Club briefing (Sept. 29)
- Neighbourhood Information Sessions - engaging public and encouraging feedback on proposed new Municipal Development Plan (MDP) and Land Use Bylaw)
  - » 8 neighbourhood sessions held across the Valley (Oct. 15 - 27)
  - » Produced publicly available “What We Heard” report consolidating feedback and changes made to drafts from feedback
- AEP Flood Hazard study release - Coordinated communication strategies and key messaging with AEP staff. Sharing content released by AEP. Encouraging homeowners to review inundation maps

River inspection, March 2020

Regulatory/approvals

Work continues on the complex regulatory and approval process that is integral to this program. This includes:

- Meeting with Alberta Environment and Parks (AEP) operations branch to identify transfer methods (moved to Q3 as a result of COVID-19)
- Continuing discussions on transfer methods
- Meetings with AEP and Public Lands to discuss the transfer of lands and dikes
- AEP Flood Hazard Mapping
  - › Released November 2020 - asking for public feedback by January 15, 2021
  - › Allows engineering firms to utilize this information as design guidelines as they start detailed design work on berms
- Held routine meetings with Palliser Regional Municipal Services, our regional planning provider
- Actively participating in monthly Municipal Planning Commission Meetings to provide strategic advice relating to flood mitigation matters
- Historical Resource application for review submitted
- Climate Lens: Greenhouse Gas Mitigation Assessment report completed
- Risk assessments - framework completed to understand homes at risk
- Property acquisitions
  - › Offers made on 19 distinct properties
  - › Offers accepted and closed on 16 properties
  - › 100 Access agreements confirmed throughout Valley
- Master Engineering Design and Planning Assessment
  - › Council gave first reading to two new bylaws on September 14 – Municipal Development Plan (MDP) and Land Use Bylaw (LUB)
    - » As reported in the latest Intact Centre Report – Provincial and Territorial Flood Report – August 2020, “Alberta reported that it falls below average in Land Use Planning.” DRFMO made land use planning a priority and

put the river at the heart of all future planning documents. This could be recognized as a leading practice in Canada
  - » Second reading passed November 23
  - » Third and final reading successfully passed December 7
  - » New documents will go into effect March 1, 2021
- Nature Based Insurance Solutions - we've been approached by Swiss RE and IBC to discuss opportunities for nature based and parametric insurance solutions. Have agreed to be a pilot program in order to learn more.

Structural measures

In 2020, we continue to work on the structural foundation for the Flood Mitigation and Climate Adaptation System:

- Winter river inspection to address stability and erosion issues
- Sourced material for berm construction for both flood mitigation project work scopes and emergency berm work
- Legal surveying of existing berms that will allow for licensing and registration of the land as part of the existing flood system
- Geography and Information Technology students from Southern Alberta Institute Technology (SAIT) commenced inventory of trees throughout the valley. This will assist in determining how much green house gas is being captured and the cooling measures. This asset inventory will also determine the life expectancy of the trees and how many replacement trees need to be maintained at the tree farm at the Drumheller Institution
- Met with the Drumheller Institution to discuss collaboration with Drumheller's inmate Work Release Program to include:
  - » Tactical emergency response planning
  - » Tree farm maintenance
  - » Manufacturing warning signs
  - » Work release programs
- Held Workshop and scoping exercise with land-use landscape architecture focused on translating mandates, story and vision for the Drumheller Valley into better defined project scopes
- Completed a review of existing MDP and LUB, and identified areas for improvement in both content and process to meet flood mitigation requirements
- Engaged in workshops and conversations with our steering and technical committees that have helped us understand the new set of intents and priorities that will shape the next decades of planning and development
- Used DRFM targets to review flood impacts, existing infrastructure, and mitigation as key variables that are giving shape to planning strategy, both for implementing flood protection, connecting the valley, and for shaping future growth
- Built a rich library of layered stories about the valley that will guide the experience and curation of the valley as a world-class destination
- Prepared a preliminary land use framework that incorporates all the considerations above
- Structural measures update and barrier alignment
- Municipal Development Plan and Land Use Bylaw – conceptual Planning framework, initial policy direction and proposed LUB approach

Flood mitigation work at Newcastle Recreation Area, July 2020

- Two meetings with the MDP/LUB impact study steering committee to review work and align direction for committee
- Preparing land assembly packages including crossing agreements and right-of-way agreements – moved to Q3 as a result of COVID-19
- Engaged Palliser Regional Planning to ensure coordination of the current and future development procedures and protocols for the Town of Drumheller
- System 2100 - embankment assessment Clark Hill to Hoodoos geotechnical drilling preparations

Dike C brush clearing: before (left) and after (right), September 2020

Conveyance capacity

An important part of this initiative is making room for the river which includes planning and outreach. The following was achieved from January – December 2020:

- Cross drain preparation and exploration for improvements
- Drainage ditch flow improvements
- Newcastle brush grubbing preparation for improvements with Drumheller Institution work release program
- Excavated 6200 m3 of material from riverbank at Newcastle to relieve impact on hospital dike erosion
- Improvements to high water swift rescue boat access
- Wayfinding sign for passive warning system – delayed due to COVID-19
- Over 5,000 trees inventoried in public lands
  - » 50 species classified and 50% of trees identified over 50 years old
- Brushing and inspection of 6.5 km of provincial dikes to determine if maintenance and repairs are required
  - » Over 20,000m^2 of brush/vegetation cleared
- Geotechnical and terrestrial assessments completed
  - » No remarkable situations acquired regarding aquatic and terrestrial assessments
  - » Geotech investigations have affirmed previous understandings regarding seepage and associated instability in some areas.

Municipal Emergency Plan

While the COVID-19 global pandemic has created unprecedented challenges to municipalities, one main benefit of the Town of Drumheller's response has been increased staff training and awareness to Incident Command System processes. Additional improvements include:

- Increased awareness ICS to all Town employees
- Email availability to all Town employees
- Council increased awareness to ICS processes and EOC operations
- Improved EOC technology

Collaborated with City of Calgary to receive a copy of their FERM (flood emergency response manual), and will adapt their process for Drumheller

- If there is a major flood event in the community CEMA will be

Drumheller Emergency Management Agency activation, March 2020

asked to support our response efforts
- Utilizing a similar response manual will provide ease of transition for CEMA staff responding

As we continue to update the MEP, we are also working on developing and expanding it beyond planned success and focusing on recovery by awfulizing potential event scenarios.

Governance

Steps have been undertaken to ensure a strong governance model is in place including the following:

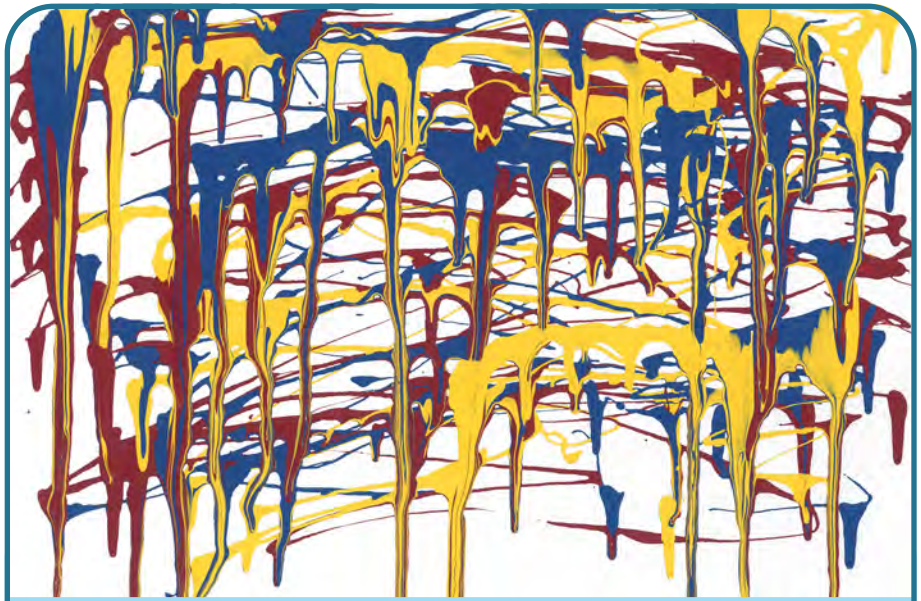
- Land Acquisition Policy adopted by Council – January 20
- Council approved a Purchasing Policy for the DRFM Program which closely follows the existing Town Policy but broadens the circumstances in which sole source purchasing may be used – January 20
- Council approved the DRFM Program Budget for 2020 - 2021

Nature Conservancy Canada

Flood office worked in cooperation with Nature Conservation Canada for a 3 month volunteer secondment. A group of 6 volunteers worked in three focus areas:

- Birds survey team
- Riparian rough camping opportunity assessment
- Conservation through art

The program concluded November 2020. The background information gathered will be used to enhance the flood program to the extent possible.



Patrick Crowchild depiction of the stratigraphy of the Drumheller badlands eroded vertically by rain.

Finance

Finance and Administration activities are a key contributing factor to the success of the Flood Mitigation and Climate Adaptation System. The following has been completed in 2020:

- Alberta Community Resiliency Program (ACRP) contract terms were agreed to with amendments

- Negotiations are ongoing for the contribution agreement with Government of Canada
- Grant investment $20,000,000 with local Credit Union
- Completed Climate Lens GHG Mitigation Assessment Draft Report
- Set up office to function as DRFM program operations center
  - » Renovations of offices including: finish walls, ceiling, floors and electrical on operations room, framing, electrical, drywall, painting operations and briefing Rooms, electrical, sprinkler relocation in operations room, flooring in operations room and install electronic equipment
  - » Hired local business to run computer cables install backbone for technology set up
  - » Installation of computer cables and monitors
- Developed and implemented record management system
- Developed and implemented organizational systems and controls
- Reviewed and established purchasing policy that acts as checks and balances for purchases within the program
- Purchased notebooks and recycled computers from local organization
- Set up accounting software and protocols
- Established backbone for information systems and flow of data and information for the DRFM Program
- Purchased and set up ARCview software for utilization
- Developed and awarded following service contracts:
  - » Centennial Park Flood Barrier Site Concept Plan – O2 Planning and Design
  - » Master Engineering Design and Assessment of Planning Impact – O2 Planning and Design
  - » Finance and Management Audit – Ascend Financial
  - » Hydraulic Analysis, Flood Mitigation Measures Overview, Conceptual Design and Cost – Northwest Hydraulics
  - » Cathodic Protection – ASM Controls
  - » Geotechnical Services – ParklandGEO Geotechnical Engineering
  - » Surveyor of Record – Hunter Surveys
  - » Surveying Services – Vector Surveying & Hunter Wallace
  - » Inspect Flood Mitigation Berms and coordinate Flood Zone Geotech – Sweet Tech Engineering
  - » Engaged services with Parkland Geotechnical Consulting, Wood Canada Ltd., SweetTech Engineering Consultants. Klohn Crippen Berger Ltd, Kerr Wood Leidal Associates Ltd
  - » Sole sourced Northwest Hydraulics to continue interpretation of provincial flood mapping that they prepared for Province
  - » South Drumheller Storm pond Design
- Engaged over 22 local companies for goods and services including:
  - » 1477834 Alberta Ltd
  - » Ascend LLP
  - » Big Country Graphics
  - » Big Country Victim Services
  - » Bright Valley Electrical
  - » Critters
  - » Drumheller Equipment Sales and Rentals
  - » Drumheller Mail
  - » Gary's Welding
  - » Grants Oilfield
  - » Kloot, Wilkins & Associates
  - » Hunter Survey Systems Ltd.
  - » Hunter Wallace Surveys
  - » James Martin
  - » Jon Sheppard Media
  - » KC Hydrovac
  - » Outlawns Tree Service
  - » Palm Engineering
  - » Reality Bytes
  - » Reg Gallagher Trucking
  - » Vector Surveys
  - » Zucatto Landscaping

Wayfinding Sign manufacturing for passive water warnings. Manufactured locally. Garry's Welding.

Climate Change Resilience Assessment Report

Future climate projections indicate that the increase in Red Deer River flows, due to rapid snowmelt and/or higher intensity rainfall events as projected by the climate models, are likely to produce great risks to the flood protection systems and the assets in the protected areas. The 2001 Muzik report concluded:

> *Small to moderate increases in rainfall intensity may have substantial impacts on flood flows, suggesting that the existing man-made infrastructures may be insufficient to deal with future floods. These results suggested that a 25% increase in extreme rainfall could lead to 40% increase in 100-year flood, 50% increase in 10-year flood, 60% increase in 3-year flood and 90% increase in 2-year flood.*

Flood events will also impact local and regional public services, due to the increased demand for emergency intervention and the need to evacuate the town.

Crews clearing brush and vegetation for provincial dike condition inspection at Dike C, September 2020

> *Flood mitigation is more than the capital investment required to build new infrastructure to minimize future risk. To maintain the resiliency of the assets you must also make operations and maintenance budgets a priority. I encourage communities to ensure adequate O&M budgets are available to maintain the life cycle of the asset.*
>
> — Dr. Guy Felio, Doctor Infrastructure

Based on the results presented in this climate risk assessment, recommendations for risk mitigation measures should be developed. Incorporating the use of standardized practices such as PIEVC and ENVISION will provide best practice guidance based on national comparisons.

- Complete a more detailed risk assessment for infrastructure components designed according to specific criteria,
- Review the design of existing flood protection dikes against projected climate change impacts.
- Consider options to increase drainage and storage capacity
- Increase availability of trained staff (including volunteer staff) to intervene in emergency situations, and further raise awareness in the community regarding flood risks and emergency preparedness
- Improve existing weather and river monitoring
- Review and improve, as needed, operations and maintenance procedures
- Review floodplain maps to reflect climate change impacts and inform land use planning.

Greenhouse Gas Mitigation Assessment Report

The objective of the GHG Mitigation Assessment is to estimate the expected GHG emissions associated with the Project and to predict changes in GHGs associated with the Project compared to a functionally equivalent Baseline scenario. In this case, the Baseline scenario considers the situation where the dike rehabilitation/construction does not take place.

Flood damages in the Town of Drumheller are expected to amount to $4,340,032.40 annually, on average. These average annual damages sum to $130,200,972 in damages over a 30-year period and $325,502,430 over the estimated lifespan of the proposed dike system (i.e. 75 years). The Project scenario involves the rehabilitation of existing dikes and the construction of new dikes over a 36-month period which will mitigate the estimated damages in the Baseline scenario and over a 75-year useful lifespan.

The Project over the span of the baseline scenario will result in an estimated net decreased of GHG emissions of 60,291 tCO_2e over the lifetime of the Project Furthermore, assuming annual damages occur in 2030 in the absence of flood mitigation, the Project will result in an estimated net GHG reduction of 949 tCO_2e in 2030.

2030 GHG Emissions Results (tCO_2e)			Lifetime GHG Emissions Results (tCO_2e)		
Baseline scenario emissions, in 2030		949	Baseline scenario emissions, lifetime (cumulative)		74,999
Estimated Project emissions, in 2030 *		0	Estimated Project emissions lifetime (cumulative) *		14,708
Net emissions	(reduction)	-949	Net emissions	(reduction)	-60,291

Taking into account the amount of effort required to build dikes (such as tree hauling, vegetation grubbing, and construction) this is a significant achievement for the project in reducing greenhouse gas emissions.

Dike B brush clearing: before (left), during (middle), and after (right), September 2020

Alberta Environment and Parks Provincial Flood Studies

Flood maps identify where water will flow during a flood, and what land could be flooded for different sized floods. Most flood maps focus on floods caused by high river flows but some also show areas at risk from ice jam floods.

With the release of this information, the engineering teams can now review their plans and finalize the berm design, a process that is expected to be complete in Spring 2020

This project by Alberta Environment and Parks (AEP) is the largest undertaking of flood mapping in Alberta's history. It covers over 1,500 kilometres of river and more than 60 municipalities and First Nations across Alberta.

In November of this year, AEP released the Drumheller Flood Study for engagement and feedback. This release includes detailed engineering reports and flood maps. The engineering reports are technical in nature and document the data, assumptions, and results of the hydrologic and hydraulic analyses needed to create flood maps.

2013 flooding at Newcastle Recreation Area

1931 flooding in Wayne

When technical work on a flood study is completed, draft reports and maps are provided to impacted local authorities, such as towns, cities, counties, municipal districts, and First Nations. Once a local authority completes its technical review and issues are addressed, public engagement proceeds. Draft reports and maps are then made available to the public, typically starting with foundational study components like flood inundation maps and followed by flood hazard maps at a later stage in the process.

This first phase of engagement is focused on the flood inundation maps that support local emergency response. AEP is planning future engagement opportunities on other study components for early next year, including the flood hazard maps that define floodways.

Local Hiring Impact

A key element of this project, beyond providing additional protective measures to the residents of the Drumheller Valley, is also providing community employment benefits for locals to engage in meaningful work.

Over the last year this project has generated 7,500 hours of local staffing including:

- Engaged over 22 small/medium-sized local businesses
- Two youth temporary positions generated
- Eight seasonal temporary employees generated
- One apprentice position generated (engineer in training)
- Two apprentices assigned to project (lawyer and surveyor)
- Eight women are engaged in the project - resulting in 10% of total hours

(From left to right) Junior Jensen, Darwin Durnie, Mayor Heather Colberg and Grant Adie unveiling the System 2100 Clark Hills to Hoodoos project, September 2020

Two GIS contractors conducting a tree survey, June 2020

River inspection, March 2020

Team meeting March 2020

Master Design and Integrating Land Use Planning

Throughout Canada, disaster mitigation is sought through ensuring the fundamentals of land use planning integrates resiliency adaptation and mitigation. We aggressively pursued a review of first principles to create a flood ready community now and through to 2100. This lead to a comprehensive discussion and plan that identified the 8 steps to encapsulate the first principles necessary to change the channel in Drumheller. The outcome created a natural opportunity to modernize the municipal development plan (MDP), the driver of all planning and strategic efforts and to modernize and modify the Land-Use Bylaw (LUB).

New modernized bylaws for the MDP and LUB were passed December 7 following an intense communication and engagement with 8 distinct neighbourhoods and 3 stakeholder groups — with an attendance of over 500 and significant implementation of digital communication tactics in order to reach all stakeholders during COVID-19 restrictions.

The review was conducted based on the following conditions:

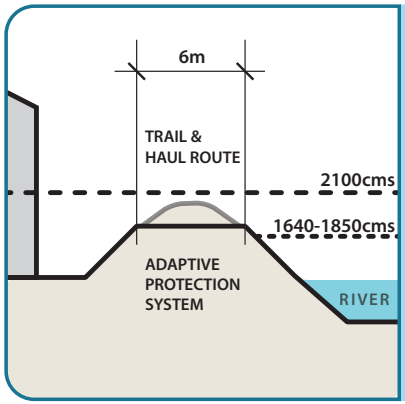
The Rivers — place the river at the heart of the Plan and understand channel capacity

The Badlands — ensure the views that make the Badlands experience are protected

Growth Areas — develop smart and attractive growth areas away from the river

Neighbourhoods — build on the unique neighbourhood identities throughout the Valley.

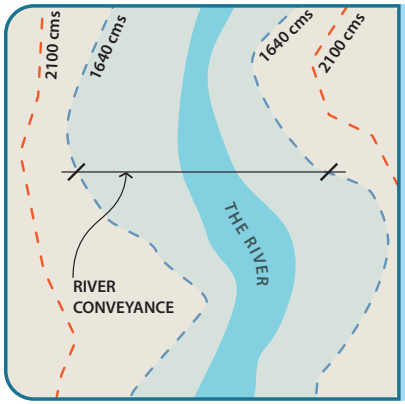
1. DESIGN BASIS



ADAPTATION

We start by **establishing a design basis**. Here, we identify the conditions that drive the design of our flood protection system. An adaptable system needs to protect to a range of flow-rates that will protect people and property in a variety of flood scenarios. We use berms that are designed to help us raise the barriers when the river rises.

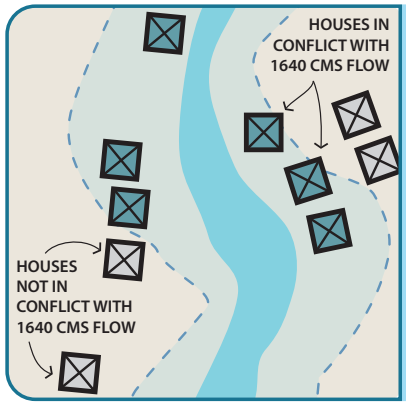
2. CONVEYANCE CAPACITY



ROOM TO FLOW

We use our target flow rates to map where the river wants to go. **The conveyance map shows us where the river needs this room to flow.** In Drumheller, there are two lines of defense: (i) 1640-1850 cms, and (ii) 2100 cms. These two lines both play important and separate roles in the multi-barrier protection system.

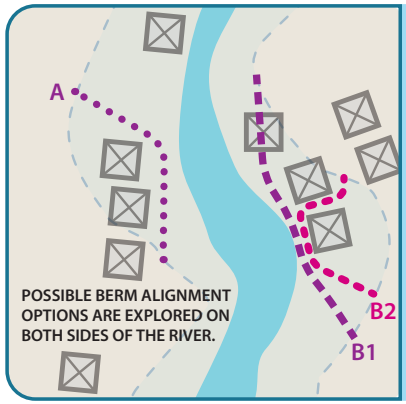
3. KNOW YOUR FLOW



UNDERSTAND THE RISK

Using the conveyance map, we can start to Know Your Flow. **Knowing Your Flow means understanding what flow rate threatens your safety and property.** Floods like those experienced in 1915 (2000 cms), 2005 (1450 cms), and 2013 (1310 cms) showed how vulnerable we can be. Knowing Your Flow helps us all prepare for the next event.

4. ALIGNMENT REVIEW

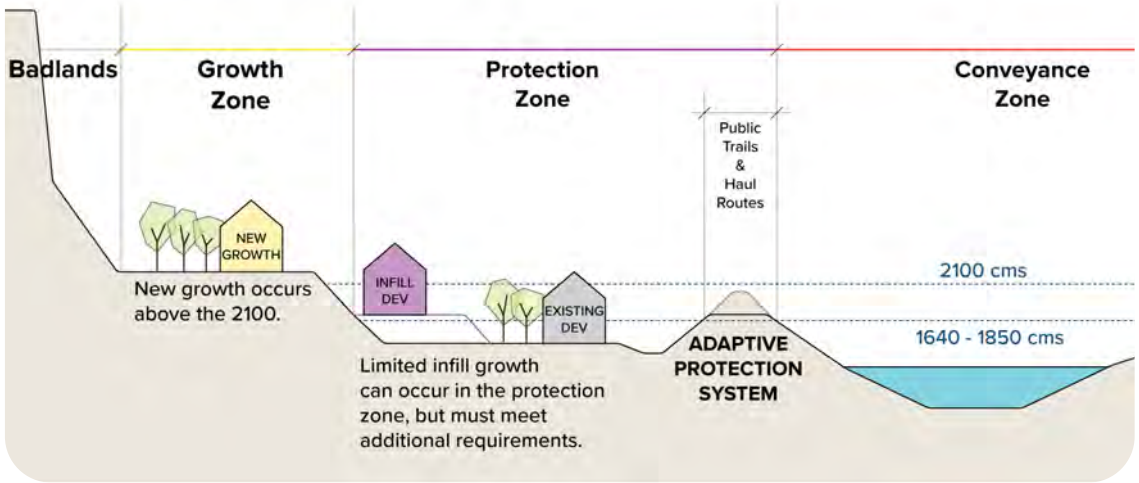


STRUCTURAL MEASURES

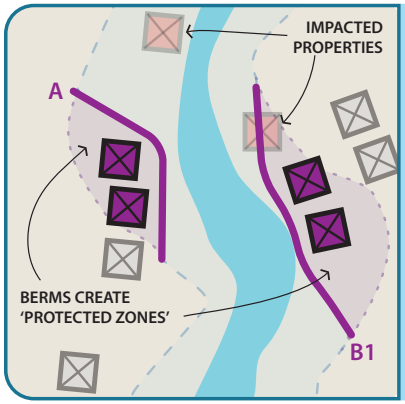
Once we know where existing development is threatened by the river, **we review potential berm alignments to understand where and what type of structural measures are feasible.** This analysis has two key goals: (i) make room for the river by keeping the channel as wide as possible, and (ii) protect existing property and assets.

What does it mean to have an adaptive system?

An adaptive system provides the best long-term protection and short-term cost and intrusion. Making berms adaptable means we can typically build them to lower elevations. It also means that the berm tops need to be wider, so that they can accept sufficient material and be used as haul routes when the barrier is being raised. In Drumheller, this means that adaptive berm tops need to be at least 6m wide. Having flat, wide berm tops enables the adaptive system, but it also unlocks other potentials to leverage flood measures for public trails and open space.



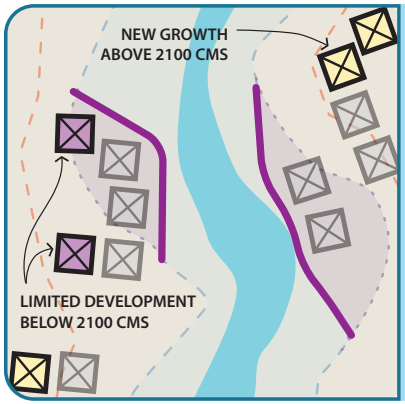
5. PROTECTED ZONE



PROTECTION ZONES

Most properties can be protected by structural measures like berms, but **some are in conflict for reasons of river capacity, berm height, geotechnical considerations, cost, or operational complication**. In the figure, one house is not feasibly protected by a berm. Another house is in the path of the berm alignment that protects the most properties.

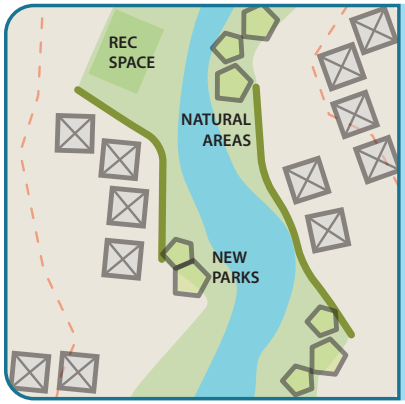
6. GROWTH AREAS



BEYOND 2100

In the coming decades, Drumheller needs to move out of the river's path. This means that **new growth will happen outside of the 2100 cms line**. Limited infill below the 2100 cms line will be subject to additional conditions that make it more flood-resilient while this gradual migration occurs.

7. CONVEYANCE ZONE



ROOM FOR THE RIVER

The area left to the river is called the conveyance zone. **In a flood, this zone provides space for the river to expand**. The rest of the time, it is home to natural spaces, recreational amenities, and low-impact uses that invite the river back into everyday life. This zone also enhances Drumheller's climate adaptation, helping store carbon and regulate micro-climates.

8. TRAILS AND OPEN SPACE NETWORK

EDUCATION

As it is completed, **flood protection will be leveraged as an amenity**. The 2100 line will become a regional trail between the train bridges at Midland and East Coulee. This trail will tie-in to local paths that will link residents to the river and the rest of the Valley's destinations. Educational pavilions along the trail will teach visitors about the history of our valley and its changing climate.

To avoid adding a whole series of specialized additional districts, the LUB can make use of overlays. These overlays apply additional technical considerations and regulations. This approach disentangles the river from the districts, making it both easier to use and to update. It also ensures that the robust technical thinking in the MDP carries through to the Bylaw.

21
Existing Land Use Districts

SIMPLIFY & CLARIFY →

8
New Land Use Districts

Badlands	Neighbourhood Centre
Rural Development	Downtown
Countryside	Tourism Corridor
Neighbourhood	Employment

DEVELOPMENT PROCESS INTENT

agile and adaptive to change
simple to use and implement
clearly articulated, not subject to broad interpretation
form-based rather than use-focused
business friendly
flexible to allow for innovation and growth
connected to the overall vision and priorities for the Valley

RIVER
ensure adequate space for the river to flow
build adaptive flood protection systems
adapt to the changing climate
develop an interconnected open space network
develop a world-class trail and pathway network
harness the river as an amenity

BADLANDS
protect critical viewsheds
maintain a sense of remoteness/solitude
protect ecological health and integrity
celebrate the badlands landscapes
curate the visitor arrival experience
foster a sense of discovery
provide an "escape" from city life
inspire locals to encourage friends & family to visit

NEIGHBOURHOODS
protect historic character and heritage assets
maintain unique neighbourhood identities
sustain a thriving downtown
enable a diversity of lifestyles and development
ensure growth is supported by existing services
nurture local tourism and recreation industries

DEVELOPMENT OPPORTUNITY
catalyze growth and investment
focus growth in safe and suitable locations
provide a range of housing tenures and types
grow within the Valley
connect the Valley for all modes of transportation

POLICY DIRECTIONS
river leading the way forward and connecting the Valley

building blocks for a locally distinct MDP

long term vision for the future of Drumheller Valley

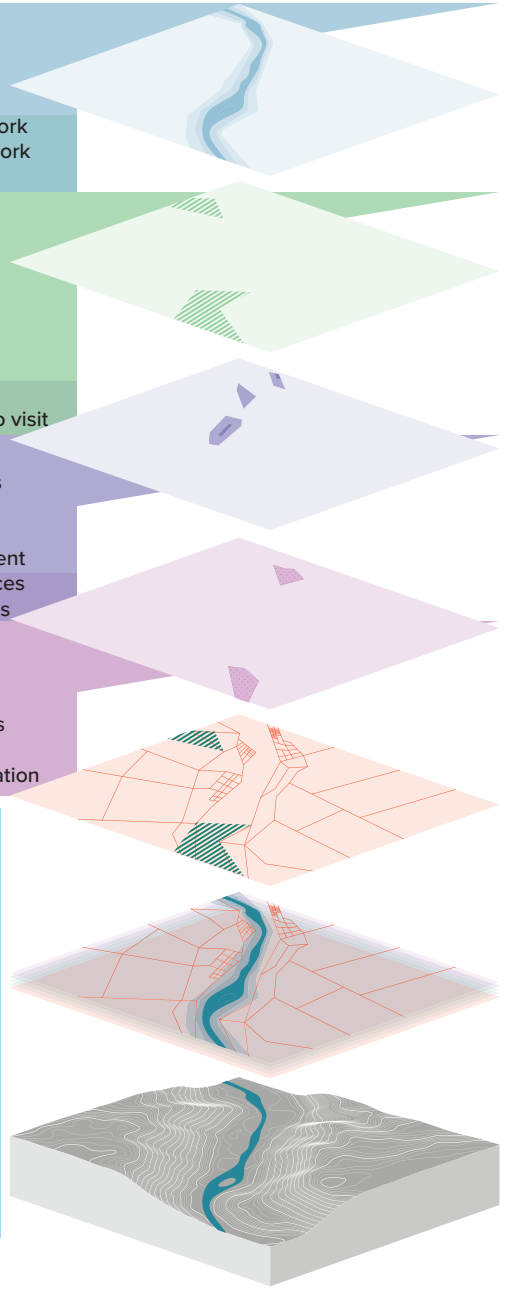
guiding principles to inform decision-making

growing in safe and strategic locations

world-class destination and a strong local economy

enhancing the unique qualities of the Valley

a community of distinct neighbourhoods



Digital communications impact

Prior to COVID-19 digital communications were already an effective and important tool for communicating to residents. This has become more important than ever now that face-to-face conversations are occuring less frequently.

We are actively engaged on social media through Facebook, Twitter, YouTube, and most recently – Instagram. We are also connecting to residents digitally via our website and through a monthly newsletter update. By building diverse strategies to engage the unique audiences within Drumheller we are starting to pick up more engagement and reach than ever before.

Newsletter:

We utilize MailChimp to send out monthly newsletters. Our subscriber base continues to steadily increase thanks to referrals from the Town, through the website and through social media advertising (both organic and paid).

Total Subscribers:	369
Q4 New Subscribers:	100
Number of Emails:	10
Avg. Open Rate:	57.7%

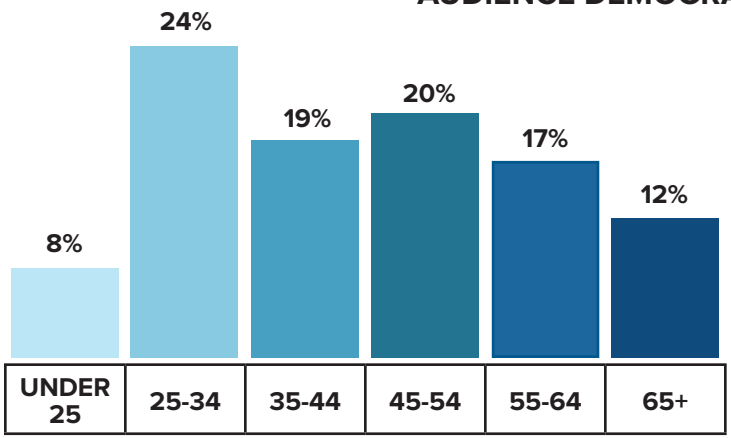
Sample newsletter, November 2020

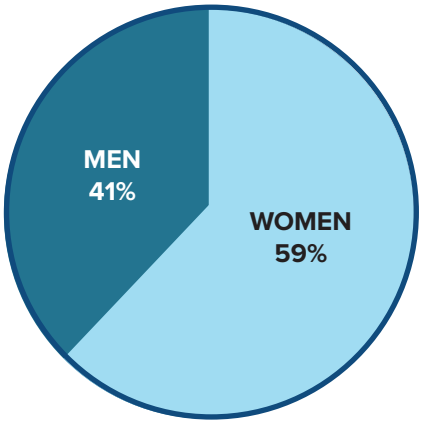
Website:

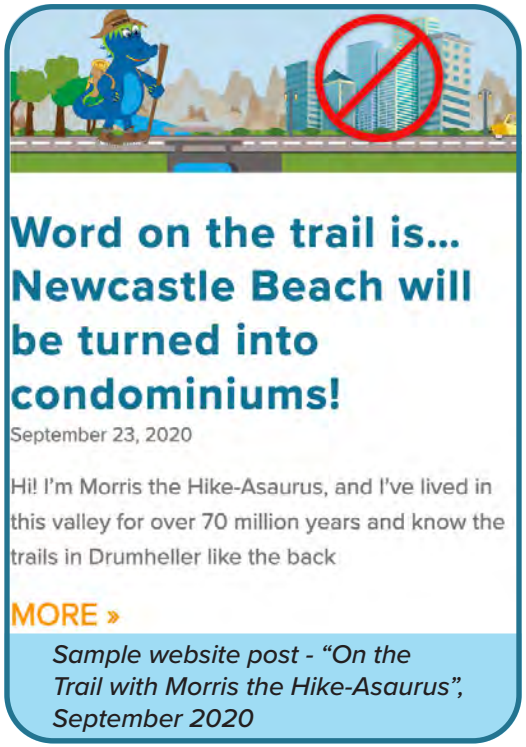
Our website is our main source of information for residents of Drumheller. We have been actively posting new information and updated FAQs on a regular basis. Since Jan. 1 we have had 45,584 impressions on Google search, with the term "drumheller flood mitigation" as our primary search term.

Sessions:	29,865
Avg. Session Duration:	1 min 5 sec
% New Sessions	67.2%
Pages/Session:	1.93

AUDIENCE DEMOGRAPHICS



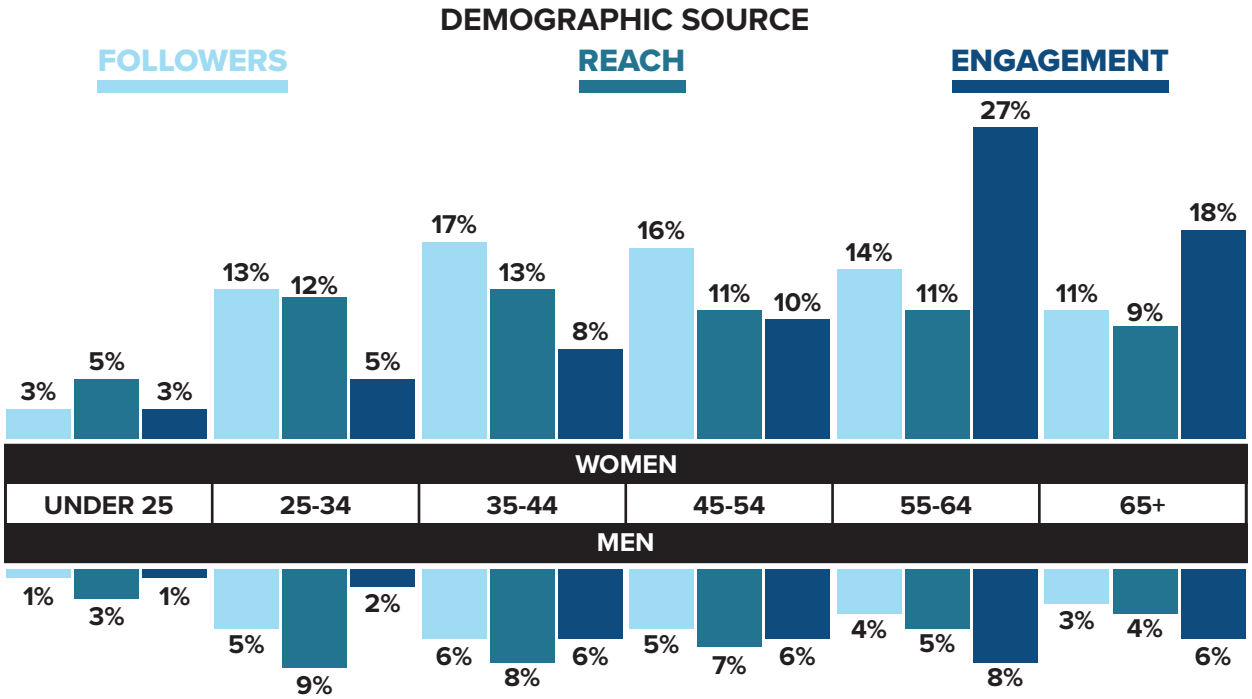


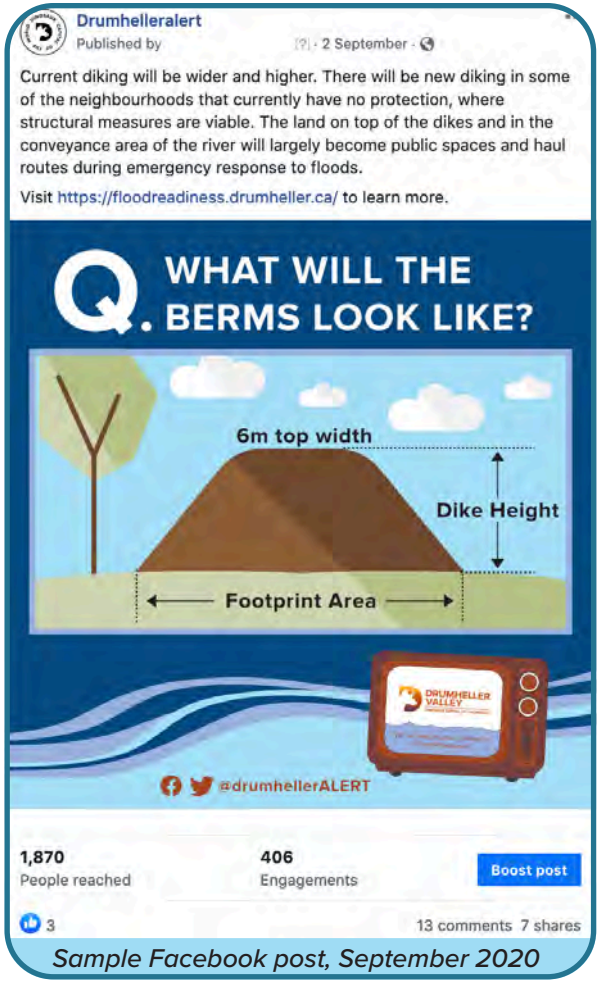


Sample website post - "On the Trail with Morris the Hike-Asaurus", September 2020

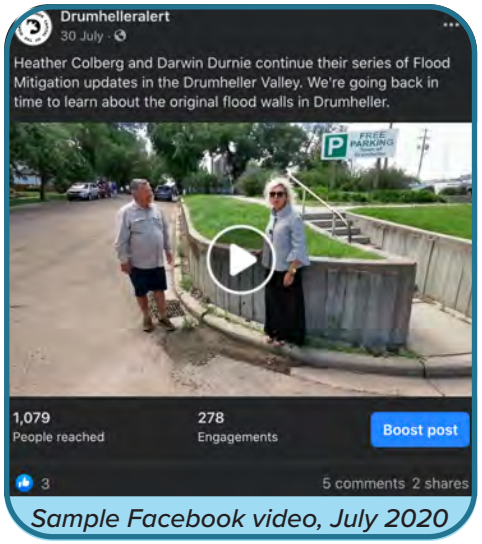
Facebook:

Facebook is our most popular social networking site that we use. An interesting finding about our followers shows that while the **majority of our followers are under 55**, the **majority of our engagers are over 55**. After an increased push on social, our reach for users under the age of 35 increased by 3%.

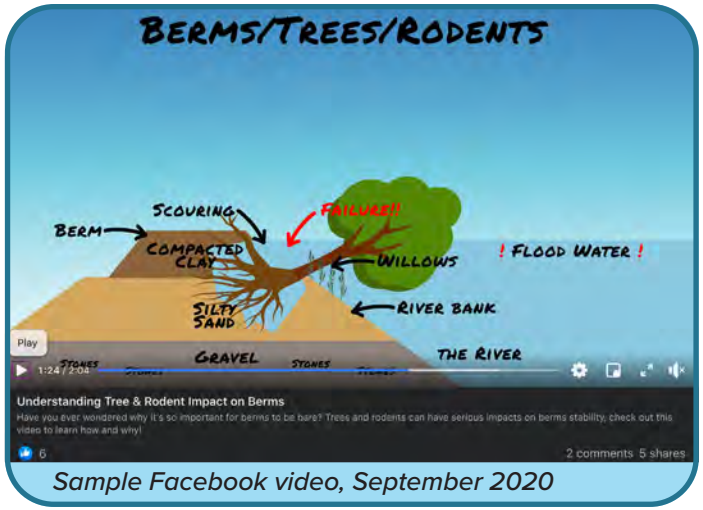




Sample Facebook post, September 2020



Sample Facebook video, July 2020



Sample Facebook video, September 2020

Facebook Live event with The Drumheller Mail, August 2020

Instagram:
Our Instagram account launched in late September. While our account is new, we hope to increase our presence particularly with those under 45 who support the flood mitigation program.

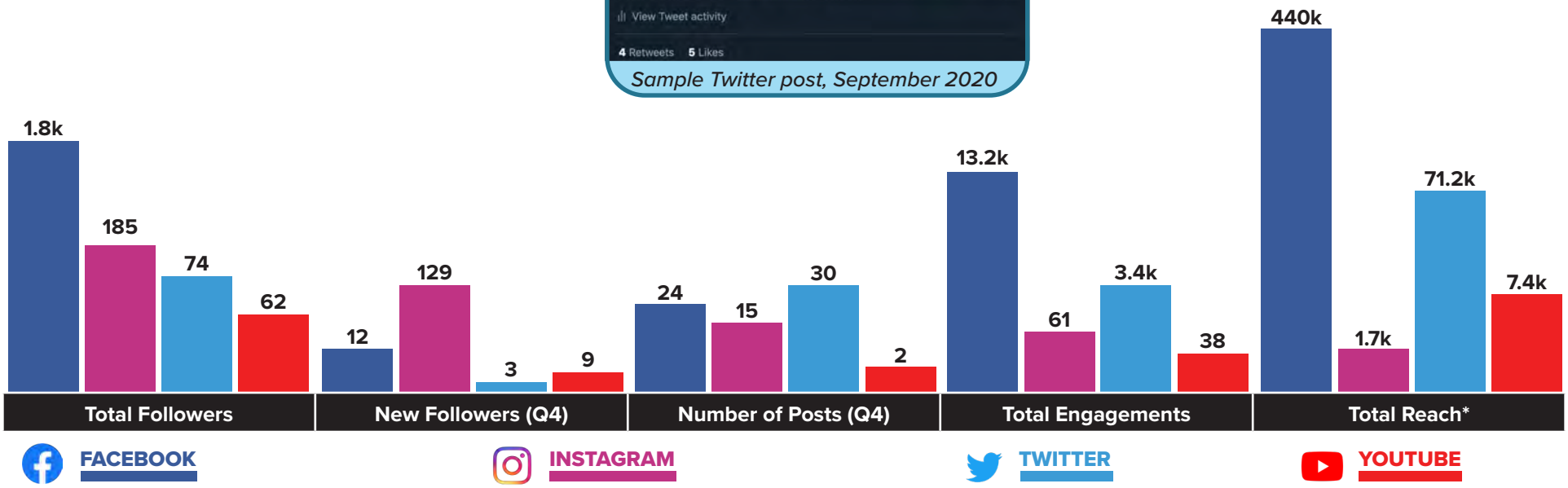
Sample Instagram post, September 2020

Twitter:
Twitter the least active platform for residents of Drumheller, however for those residents we are reaching the engagement is very high.

Sample Twitter post, September 2020

YouTube:
YouTube is one of our primary tools for video hosting. We continue to focus on video content overall across our social media strategy.

Sample YouTube post, September 2020



*Twitter is showing impressions and YouTube is showing video views

O2 Planning & Design River Tour, August 2020

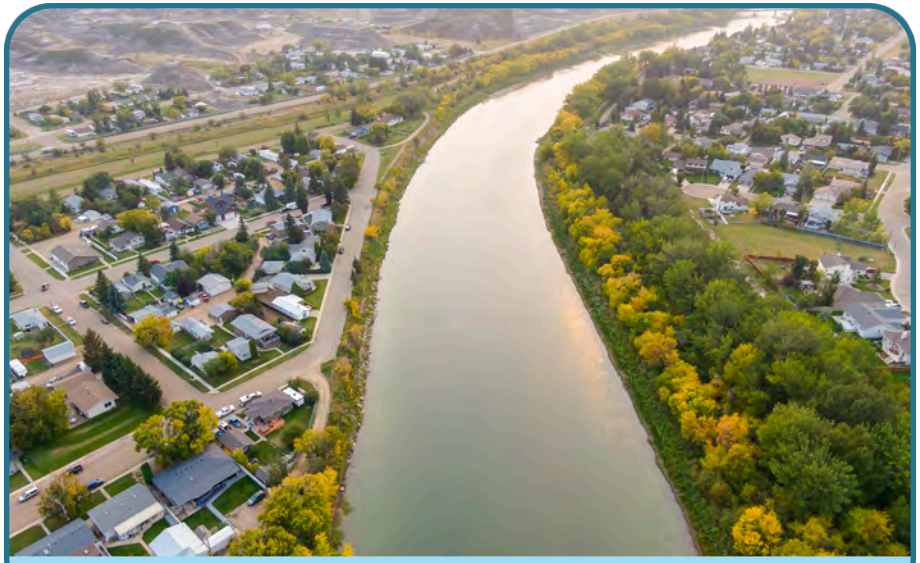
MDP and LUB Neighbourhood Information Sessions, October 2020 (locations clockwise from top left — Last Chance Saloon (Wayne), East Coulee School Museum, Newcastle Community Hall, Rosedale Community Hall

Morris at Family Day event, February 2020

River inspection, March 2020

Drumheller Farmer's Market, September 2020

MDP and LUB Neighbourhood Information Sessions, October 2020 (locations clockwise from top left — Nacmine Community Hall, Midland Community Hall, Badlands Community Facility (BCF) – morning session, BCF – evening session



Aerial footage of Drumheller, September 2020

What is Art – painting by Patrick Crowchild

Dike D brush clearing: before (left) and after (right), September 2020

Moving forward

Next year we look forward to finalizing the berm alignment and design, working with Alberta Environment and Parks on transferring their dikes to the town, and confirm berm construction contracts. While 2020 was busy with planning, assessments and studies, we look forward to the action phase so we can increase the protective measures in the Valley.

Q1 (Jan - Mar)

- Flood Emergency Response Manual Updates
- “Know Your Flow” campaign launch
- Complete berm alignment and design
- Stakeholder engagement berm design
- ROW plans registered
- Urban Tree Strategy completed
- Water Act, Navigable Waters, Fisheries/Oceans applications
- Public Land Dispositions
- Riprap delivery
- New MDP/LUB adopted
- Indigenous Consultation completed
- Historical resource application confirmed

Q2 (Apr - Jun)

- Tender 2021 - 2023 works
- 2021 Flood Season
- AEP Dike Transfer
- ROW crossing agreements
- ROW Assembly
- Virtual Flood Forum
- Confirm suitability rail embankments
- Pursue active transportation funding
- “Know Your Flow” implementation with 2021 flood season
- Orientation of Flood Emergency Response Manual
- Appendix to dike system operation manual

- Development process and modernization to aggressively include flooding
- Inter-municipal development plans updated
- Inter-municipal collaboration framework (ICF) plans updated
- Stakeholder engagement with surrounding municipalities
- Staff training on new MDP/LUB

- Commence armour (riprap) stockpiles and borrow area development
- Commence early works Centennial Park, Newcastle, Hoodoos
- Haul route establishment
- Tentative start rail enbankment modifications for dikings (system 2100)

Q3 (Jul - Sep)

- Berm construction contracts awarded
- ROW assembly
- Commence buyout program disposals
- Finalize conveyance capacity preservation
- Know Your Flow Education Series walking lectures
- Coordination with Travel Drumheller tourist information education series - Know Your Flow
- Coordination with Travel Drumheller restaurant education tray liners
- Review AEP updated flood hazard maps
- Launch social media campaign reflecting AEP updated flood hazard maps
- Continue haul route establishment

Q4 (Oct - Dec)

- Commence construction activities
- Municipal Elections
- Commence Construction activities
  - » Armouring and instream construction
  - » Complete 2 km+ dike construction
- Education plaza location confirmation
- Drumheller Emergency Management Agency Annual Exercise
- Grade 4 and Grade 9 education series
- Drumheller Resiliency and Flood Mitigation orientation to new council members
- ICF updates completed
- Grant claims
- 2022-2025 budget adopted by council

OUR COMMITMENT

As a community dedicated to a safe and prosperous future, both on the housing, economic and cultural front, we are writing the next chapter of our story and ensuring a resilient and flood ready future. It takes a whole community approach, and together with our partners in the provincial and federal governments, we will preserve the Dinosaur Capital of Canada and share our story of adapting to a changing climate with the world.

WE ARE A FLOOD COMMUNITY

The story of Drumheller is one of changing climate. It started under a layer of ice which melted to reveal a treasure trove of fossils deposited by the mass extinction of the dinosaurs. As the melting water sliced deep through the Great Plains, it eroded 75 million years of geological layers and created the Canadian Badlands. Of a population of 8,000 there are 2,344 residents in 1,045 dwellings at risk of direct inundation in a 1% return flood event.

Drumheller is the 3rd largest tourist destination in Alberta, but has seen its fair share of adversity from mother nature in terms of flooding:

June 27, 1915 (rain on snowmelt)
April 2, 1967 (ice jam)
June 18 1931 (rain on snowmelt)
June 23, 2005 (rain on snowmelt)
April 21, 1948 (ice jam)
June 21, 2013 (rain on snowmelt)
August 26, 1954 (rainfall)
April 24, 2018 (ice jam)

The Drumheller Flood Mitigation and Climate Adaptation System (DFMCAS) is a multi-hazard solution covering 100 kilometers of riverbank, that has been designed to reduce flooding and protect Drumheller into the 22nd Century. It began in April 2019 and will end March 2024. The total cost is shared by three orders of government: $22M Canada, $28M Alberta, $5M Drumheller.

Focus Areas

Communications & Engagement

1. Promote Drumheller's approach to adapting to the perils of changing climate
2. Continuing to unite the community behind a shared purpose to protect Drumheller's economic, environmental and cultural assets from flooding
3. Consult and engage with impacted indigenous communities
4. Position Drumheller as an innovative leader in the area of flood mitigation and readiness
5. Inform affected residents of a 'fair and balanced' approach to land acquisition process
6. Communicate and work with financial and insurance sectors on viable solutions for displaced homeowners

Regulatory & Approvals

1. Obtain transfer of existing dikes from Alberta Environment and Parks (AEP) to Town of Drumheller
2. Meet obligations of funding agreements
3. Collaborate with AEP on revised Flood hazard maps
4. Encourage economic development through updated MDP and LUB by ensuring future development proceed in areas not subject to flood risks

Conveyance Capacity

1. Make room for the river – preserve channel capacity
2. Ensure Drumheller is prepared for inevitable flooding events caused by either an ice jam, high flow levels or intensive rainfall
3. Preserve up to 1,200 acres of natural (riparian) area that is comparable to 3,200 family cars of carbon capture per year
4. Develop a fair and balanced land acquisition policy for impacted homeowners

Structural Measures

1. Build an adaptive system to protect the community into the 22nd century
2. Protect the cultural, palaeontological and archaeological treasures of the Red Deer River Valley
3. Develop recreational and educational interpretive centers as part of the improved flood mitigation system
4. Connect the Royal Tyrrell Museum to the Atlas Coal Mine via a 38 kilometre "2100 trail network" as part of the improved flood mitigation system

Municipal Emergency Plan (MEP) Enhancement

1. Develop detailed flood mitigation system operations manual to accompany MEP
2. Divide river valley into manageable monitoring sectors that will allow regional partners to respond/assist appropriately to their assigned area of responsibility during emergencies
3. Establish a Flood Mitigation and Climate Adaptation operations center to effectively respond during a flood emergency
4. Implement Incident Command System (ICS) protocols throughout flood mitigation and climate adaptation office to educate staff on processes
5. Conduct annual exercises using ICS

Achievements

- Residents were and continue to be engaged and supportive of flood mitigation and climate adaptation system
- Town of Drumheller enhances relationship with Indigenous communities as a result of consultation process
- Residents agree Town of Drumheller is a flood community
- Residents have increased knowledge about flooding in Drumheller

- All existing provincial dikes are transferred to Town of Drumheller
- Revised provincial flood hazard maps are implemented in collaboration with Town of Drumheller
- Future flood plain development in Drumheller is improved through changes to MDP and LUB
- Support from funding partners is maximized

- Channel capacity in Red Deer River is improved/preserved
- Land Acquisition program is successfully completed to remove structures from floodway
- Innovate environmental initiatives were implemented to preserve riparian areas and urban forests
- Projected green house gas reductions of 3200 cars per year equivalent is met

- Enhanced diking system withstands future flooding by being adaptive to future
- Diking network between Royal Tyrrell Museum and Atlas Coal Mine serves as experiential education system for 500,000 annual visitors
- Majority of projected 20,000 man hours to complete work are hired locally

- Town of Drumheller staff are trained to respond to future flooding
- Regional partners manage prescribed monitoring sectors of the river valley
- MEP is updated and meets Bill 8 requirements

Goal

The Town of Drumheller has protected the residents and property from loss or injury related to the perils of floods and changes in climate. The risk to property is reduced, thereby preserving economic viability of the community.

Success

- Confidence of residents
- Decreased vulnerability and exposure areas
- Increased economic activity in 5 years
- Increased river capacity
- Improved climate adaptation
- Increased staff capacity to respond to future emergencies

Risks

- Increasing likelihood of natural disasters
- Changes to the provincial flood hazard maps
- Project delays due to regulatory & approvals process
- Loss of local human resource expertise
- Ineffective communication and engagement

Drumheller Flood Mitigation and Climate Adaptation System

Changing the Channel on Flood Readiness

December 2020

DRUMHELLER IS A FLOOD COMMUNITY

8,000
POPULATION

12
NEIGHBOURHOODS

100
KILOMETRES OF RIVERBANK

HISTORIC FLOOD YEARS

1902 1915 1932 1954 1991 2005 2013 2018

ROI

EXCEEDS 2:1

GOALS

- Making room for the river
- Reinforcing existing measures
- Building an adaptive system to protect the community into the 22nd century
- Changing the channel on flood-readiness

Green House Gases

3200 cars per year equivalent land preservation area dedicated

2019
COMMENCE DATE

2024
COMPLETION DATE

20,000+
STAFFING HOURS

7,500
LOCAL STAFFING HOURS
(JANUARY - DECEMBER)

The next historic flood is not a matter of "**IF**" but "**WHEN**"