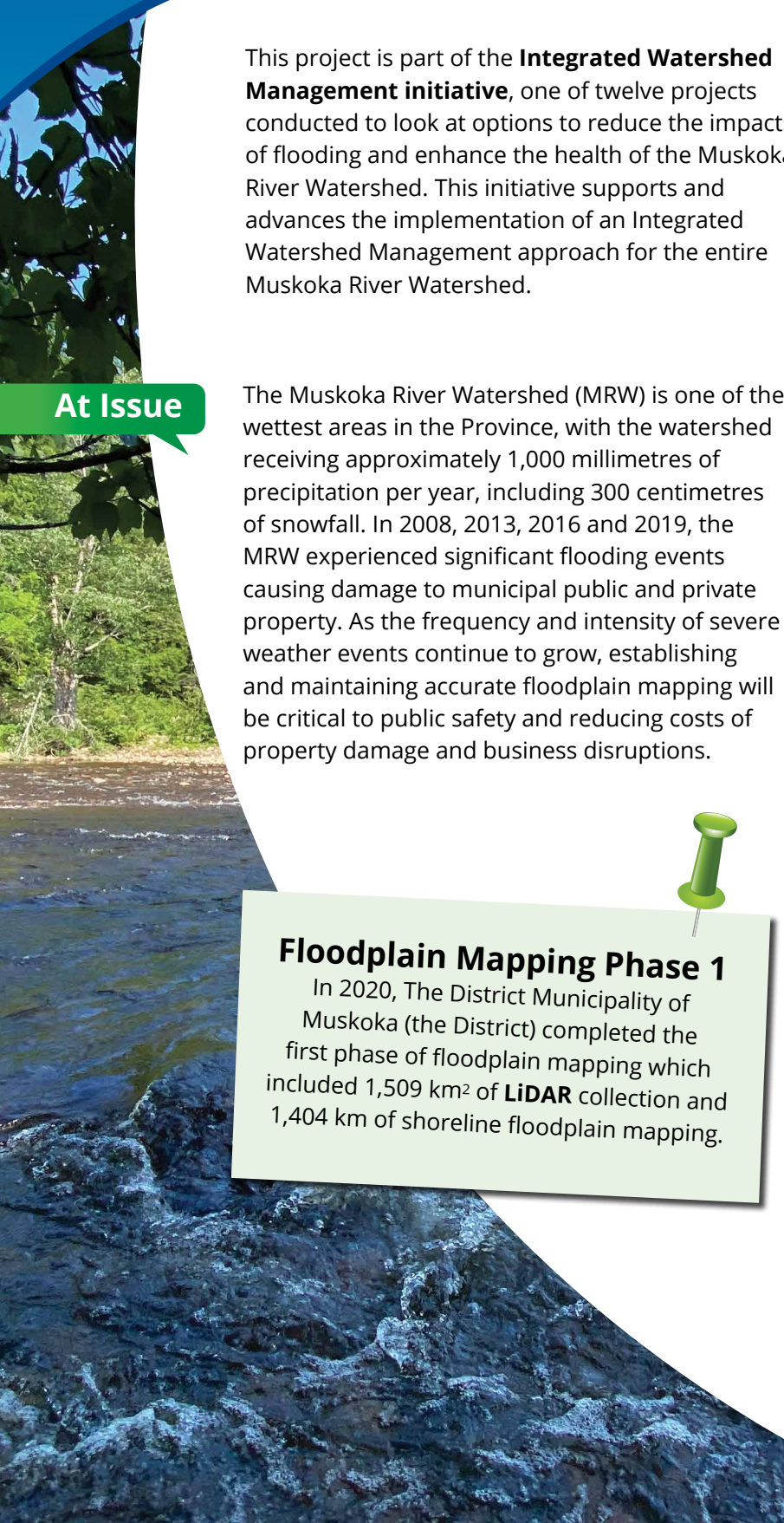
FLOODPLAIN MAPPING
Report Summary

THE DISTRICT MUNICIPALITY OF MUSKOKA



This project is part of the **Integrated Watershed Management initiative**, one of twelve projects conducted to look at options to reduce the impacts of flooding and enhance the health of the Muskoka River Watershed. This initiative supports and advances the implementation of an Integrated Watershed Management approach for the entire Muskoka River Watershed.

At Issue

The Muskoka River Watershed (MRW) is one of the wettest areas in the Province, with the watershed receiving approximately 1,000 millimetres of precipitation per year, including 300 centimetres of snowfall. In 2008, 2013, 2016 and 2019, the MRW experienced significant flooding events causing damage to municipal public and private property. As the frequency and intensity of severe weather events continue to grow, establishing and maintaining accurate floodplain mapping will be critical to public safety and reducing costs of property damage and business disruptions.

Floodplain Mapping Phase 1

In 2020, The District Municipality of Muskoka (the District) completed the first phase of floodplain mapping which included 1,509 km^2 of **LiDAR** collection and 1,404 km of shoreline floodplain mapping.

What is a floodplain?

A floodplain is the natural flat area next to a river or stream that can convey extra water that spills out of the river channel during a flood event. Normally this area is dry and not covered by water.

Healthy floodplains yield multiple benefits for the community including flood protection and erosion control, improved water quality, recharged aquifers, improved wildlife habitat and recreational opportunities.

Floodplain mapping studies are technical reports that identify areas susceptible to flooding during large storm events. Floodplain mapping relies on field surveys, engineering analysis and hydrologic and hydraulic modelling.

Hydrologic modelling predicts how much stormwater will runoff the land during a rainfall event. The flows generated by the hydrologic model are then input into a hydraulic model which routes these flows through the river system to predict the peak flood depth.

Floodplain mapping improves flood management response and helps everyone to understand their flood risk. It's a critical component of emergency management plans as they outline potential flood hazards that help decision-makers with flood preparedness, flood mitigation, and land use planning.

Project Scope

This project will expand floodplain mapping to cover over 910 km^2 of the MRW, including large areas in the Township of Georgian Bay, Lake of Bays, the Moon and Musquash Rivers, and lakes and river sections not captured in the first phase. In addition, the District has committed to providing the **LiDAR** and floodplain mapping data to Moose Deer Point First Nation and Wahta First Nation to help inform their planning and emergency management decisions. The project outcomes will assist in emergency management and response plans, inform land use planning policies and help determine areas at risk of flood damage. The full scope of the project includes:

- ✓ 910 km^2 of LiDAR survey topographic mapping data.
- ✓ Peak static water levels for floodplain mapping on lakes.
- ✓ New and updated floodplain mapping for 110 km of river reaches.
- ✓ New floodplain mapping for 1,160 km of lake shorelines.
- ✓ **HEC-RAS** river hydraulic models for floodplain mapping of select river reaches.

LiDAR (Light Detection and Ranging) is a remote sensing method that involves scanning the ground with millions of laser pulses emitted from a device mounted to a plane to generate a 3D representation of the ground.

HEC-RAS is a computer program that models the hydraulics of water flow through natural rivers and other channels.

Study Areas

NBMR* - Bracebridge	Three Mile Lake
NBMR* - Mary Lake	Skeleton Lake
NBMR* - Port Sydney	Kahshe Lake
SBMR* - Fraserburg	Gloucester Pool
SBMR* - Matthias	Six Mile Lake
Moon River	Go Home Lake
Musquash River	Leech Lake
Bent River	McKay Lake
Black River	Pine Lake
Lake of Bays	Prospect Lake
Georgian Bay	Wood Lake
Twelve Mile Bay	Healey Lake
Stewart Lake	

**NBMR = North Branch Muskoka River*
SBMR = South Branch Muskoka River

Methodology and Analysis

1 Data Collection

- **LiDAR** covering 2,700 km^2 (combined total from current and previous floodplain mapping projects).
- **Bathymetry** of cross-sections survey along Kahshe, North and South Muskoka, Musquash, Bent, Black, Gibson and Moon Rivers.

2 Hydrologic Analysis

Hydrologic analysis was set up and calibrated to establish the **Regulatory Flood** for each study area. Model data inputs included:

- precipitation and temperature
- lake elevation storage
- spillway discharge rating curve

Summary

- Both the 2013 and 2019 recorded peak flows throughout the watershed were greater than the current 1:100-yr flood.
- The Timmins storm was determined to yield the largest flood in the smaller catchment areas within the watershed and therefore is considered the regulatory event for these areas.

3 Climate Change

Recommended Increase in Regulatory Flood Magnitude to Address Climate Change

River Reach	Regulatory Flood	Climate Escalation Recommendation
NBMR* - Bracebridge	2019 Flood	+15%
NBMR* – Mary Lake	2019 Flood	+15%
NBMR* – Port Sydney	2019 Flood	+15%
SBMR* - Fraserburg	2019 Flood	+15%
SBMR* - Matthias	2019 Flood	+15%
Moon River	2019 Flood	+5%
Musquash River	1:100-yr	+5%
Bent River	Timmins Storm	Not Required
Black River	1:100-yr	+15%

4 River and Lake Hydraulic Modelling

- Models of each of the selected river reaches were created using HEC-RAS.
- The HEC-RAS model geometry was created using a combination of LiDAR data and bathymetric data from the river reaches.
- Models were calibrated using available flow and water level data along the rivers.
- Model outcomes include the maximum water levels corresponding to the Regulatory Flood with the assumed climate change impact.

Bathymetry is the measurement of the depth of water in oceans, rivers, or lakes. Bathymetric maps look a lot like topographic maps, which use lines to show the shape and elevation of land features. On topographic maps, the lines connect points of equal elevation. On bathymetric maps, they connect points of equal depth.

How Does Muskoka Define Flood Risk?

Regulatory Flood means the flood having a one percent (1%) chance of being equaled or exceeded in any given year.

A regulatory flood for the Muskoka River Watershed (Zone 3, Ministry of Natural Resources and Forestry – Flood Hazard Criteria) must be the greater of the following three events:

- **1:100-Year Flood** refers to a flood height that has a likelihood of occurring once in 100 years.
- **Timmins Storm** floods are based on an extreme rainfall event that occurred in the Timmins region on September 1, 1961.
- **Muskoka Flood of Record** refers to major flood events in the spring of 2013 and 2019, resulting from heavy rainfall on a large melting snowpack. The 2013 flood produced the highest flood peaks in the upper MRW, while the 2019 flood produced the highest flood peaks in the lower MRW, due to the greater regulating storage in the lower basin.

"The mid-century projections for Muskoka reveal about a 10% increase in the total amount of precipitation in a typical year. Nearly all this increase is likely to occur in late fall to early spring (November through April) for a 17% increase in the total for those 6 months (524 mm compared to 446 mm at present)."

Muskoka Watershed Council - Planning for Climate Change in Muskoka
(Peter Sale, Richard Lammers, Norman Yan, Neil Hutchinson, Kevin Trimble, Paul Dinner, Piret Hurrell, Jan McDonnell, and Scott Young, 2016)

Floodplain Maps

- A typical floodplain map shows the flood extents along the river or around the lake during the Regulatory Flood.
- Maps were produced for 110 km of river reaches and 1,160 km of lake shorelines.
- Maps of Georgian Bay and Twelve Mile Bay include a 15 m horizontal buffer to account for **wave uprush**.
- Maps are approximate.

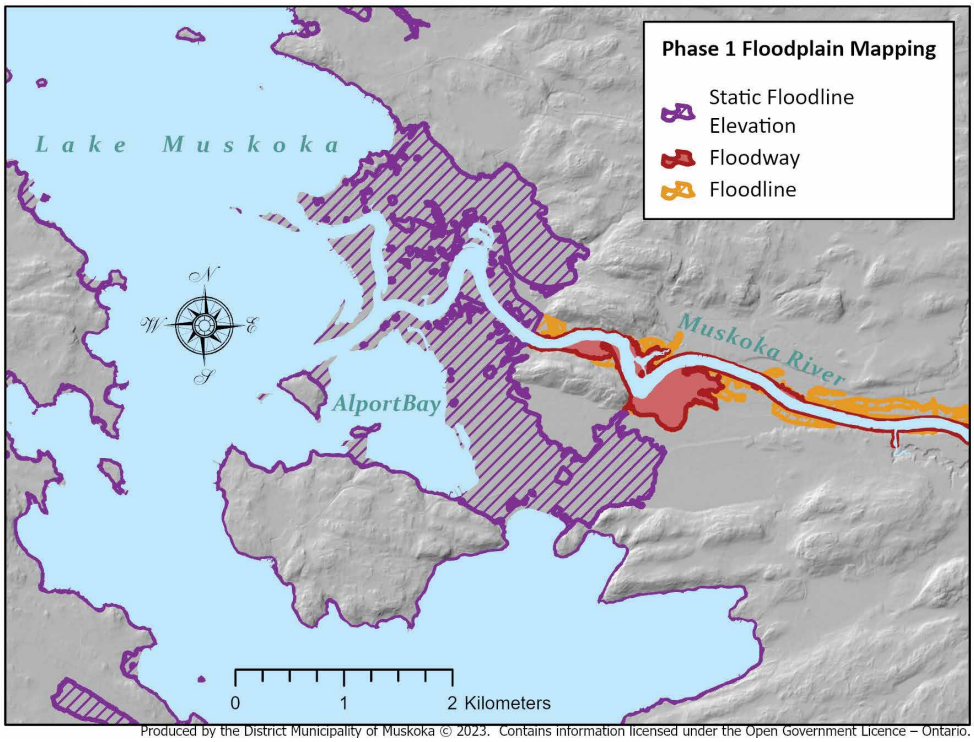
Wave Uprush means the rush of water up onto a beach, bluff or structure following the breaking of a wave. The limit of wave uprush is the point of farthest landward rush of water onto the shoreline.

PDF copies of all floodplain maps generated from this study and Phase 1 are available on the **District website**.

Interactive Phase 1 mapping is also on **Muskoka GeoHub** website. Phase 2 will be added in the future.

The floodplain maps allow municipalities and individuals to identify river and lake floodplains, including identifying critical infrastructure and population at-risk sites that may require protective measures, warnings and evacuation planning.

Example of Floodplain Mapping - Phase 1



Static Floodline Elevation – applies to lake floodplains, where the flood elevation is consistent all the way around the lake.

Floodway and Floodline - apply to river floodplains, where the flood elevation varies as you travel upstream or downstream, and flow velocities are considered.

Floodway – floodplain area with sufficient depth and/or velocity to create life safety risk, according to Ministry of Natural Resources and Forestry guidelines.

Floodline – the outer portion of the floodplain, which may still experience flooding, but the water depth and velocities are generally less severe than in the floodway.

Recommendations

Several recommendations were provided in the report under the following categories:

- Wave uprush
- Watershed management and education
- Flood forecasting and tracking
- Mitigation options

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To read the full report, learn more about Integrated Watershed Management and the associated projects in the Muskoka River Watershed visit: muskoka.on.ca/IWMprojects.

This project has received funding support from the Government of Ontario.
Such support does not indicate endorsement by the Government of Ontario of the contents of this material.

Making Waves:
Protecting the Muskoka River Watershed