Municipality of Lakeshore
Shoreline Management Plan
Final Report

Prepared for:
Municipality of Lakeshore

Prepared by:
Stantec Consulting Ltd.
in partnership with
Zuzek Inc. and SJL
Engineering

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Sign-off Sheet

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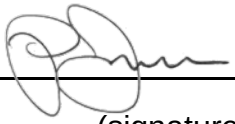
Prepared by 

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Executive Summary

Stantec Consulting Limited in partnership with Zuzek Inc. and SJL Engineering Inc. were retained by the Municipality of Lakeshore to prepare a Shoreline Management Plan for the Lake St. Clair shoreline within their jurisdiction. This report summarizes relevant government legislation, the technical investigation to generate updated coastal hazard mapping, areas of high vulnerability due to coastal flooding, and management recommendations to re-risk the community and increase resilience to future coastal flooding events.

There is a strong provincial and municipal policy and regulatory regime in Ontario to ensure new development is located away from hazardous lands adjacent to the Great Lakes and Connection Channels. Following mapping standards, the erosion, flooding, and dynamic beach hazard mapping for the Municipality of Lakeshore was updated with this study based on historical extremes. Unfortunately, a significant portion of the Lakeshore waterfront and development along the local rivers has occurred on floodprone lands.

The Provincial Policy Statement now mandates Municipalities to have regard to the impacts of a changing climate when planning for the risks associated with natural hazards. Based on the best available science on the impacts of climate change for future lake levels, the 100-year lake level is projected to increase by approximately 0.3 m for Lake St. Clair with global warming of 1.5 to 2.0°C. Based on projections from the Intergovernmental Panel on Climate Change (IPCC), this amount of warming will occur over the next couple of decades.

At the time of this report preparation, there was no technical guidance from the Province of Ontario on how to integrate the impacts of a changing climate for erosion, flooding, and dynamic beach hazard mapping. In the absence of defensible technical methods, a sensitivity analysis was completed at three locations (Pike Creek, Puce River, and Belle River) based on best available data (refer to Section 4.4) to highlight the extent of flood risk and road inundation with the historical 100-year lake level and the 100-year climate change lake level. Refer to the results for Pike Creek below. The extent of building flooding and road inundation is extensive for the 100-year lake level, and it gets incrementally worse with Climate Change (right image below).

100-year Lake Level (176.39 m, IGLD'85) at Pike Creek	100-year Climate Change Lake Level (176.77 m, IGLD'85) at Pike Creek
	

The results of the technical analysis and review of land use management approaches indicate a clear direction that the extent of the lands susceptible to the flooding hazard along the Lake St. Clair shoreline should be updated in municipal and conservation authority implementation mapping, in particular the lands identified as the Lake St. Clair Floodprone Area.

There is a significant risk that additional areas will be rendered inaccessible during times of flood hazard events and the inability to access private and commercial property by first responders (fire, ambulance, police) during a coastal flooding event is a key challenge.

As depicted above, the flood risk is further augmented with the introduction of the 100 year climate change lake level, presenting a significant risk to infrastructure, buildings, and threats to human safety. This risk therefore should be integrated into Lakeshore's strategic policy direction and opportunities for increasing climate resiliency can be integrated into all significant municipal decisions.

Glossary

Italicized terms throughout this Report are intended to mean the definitions contained herein.

Access standards:

Methods or procedures to ensure safe vehicular and pedestrian movement, and access for the maintenance and repair of protection works, during times of flooding hazards, erosion hazards and/or other water-related hazards.

Defined portions of the flooding hazard along connecting channels:

Those areas which are critical to the conveyance of the flows associated with the one hundred year flood level along the St. Marys, St. Clair, Detroit, Niagara and St. Lawrence Rivers, where development or site alteration will create flooding hazards, cause updrift and/or downdrift impacts and/or cause adverse environmental impacts.

Development:

The creation of a new lot, a change in land use, or the construction of buildings and structures requiring approval under the Planning Act.

Dynamic beach hazards:

Areas of inherently unstable accumulations of shoreline sediments along the *Great Lakes – St. Lawrence River System* …, as identified by provincial standards, as amended from time to time. The *dynamic beach hazard* limit consists of the *flooding hazard* limit plus a dynamic beach allowance.

Great Lakes – St. Lawrence River System:

The major water system consisting of Lakes Superior, Huron, St. Clair, Erie and Ontario and their connecting channels, and the St. Lawrence River within the boundaries of the Province of Ontario.

Hazardous lands:

Property or lands that could be unsafe for development due to naturally occurring processes. Along the shorelines of the *Great Lakes – St. Lawrence River System*, this means land, including that covered by water, between the international boundary, where applicable, and the furthest landward limit of the *flooding hazard*, *erosion hazard*, or *dynamic beach hazard* limits.

Erosion hazards:

The loss of land due to human or natural processes, that poses a threat to life and property.

Flood proofing standards:

The combination of measures incorporated into the basic design and/or construction of buildings, structures, or properties to reduce or eliminate flooding hazards, wave uprush and other water related hazards along the shorelines of the Great Lakes - St. Lawrence River System and large inland lakes, and flooding hazards along river, stream and small inland lake systems.

Flooding hazards:

The inundation, under the conditions specified below, of areas adjacent to a shoreline… and not ordinarily covered by water: a) along the shorelines of the *Great Lakes – St. Lawrence River System …* the *flooding hazard* limit is based on the *one hundred year flood level* plus an allowance for *wave uprush* and *other water-related hazards*.

Natural heritage features and areas:

Features and areas, including significant wetlands, significant coastal wetlands, other coastal wetlands in Ecoregions 5E, 6E and 7E, fish habitat, significant woodlands and significant valleylands in Ecoregions 6E and 7E (excluding islands in Lake Huron and the St. Marys River), habitat of endangered species and threatened species, significant wildlife habitat, and significant areas of natural and scientific interest, which are important for their environmental and social values as a legacy of the natural landscapes of an area.

Natural heritage system:

A system made up of natural heritage features and areas and linkages intended to provide connectivity (at the regional or site level) and support natural processes which are necessary to maintain biological and geological diversity, natural functions, viable populations of indigenous species, and ecosystems. These systems can include natural heritage features and areas, federal and provincial parks and conservation reserves, other natural heritage features, lands that have been restored or have the potential to be restored to a natural state, areas that support hydrologic functions, and working landscapes that enable ecological functions to continue. The Province has a recommended approach for identifying natural heritage systems, but municipal approaches that achieve or exceed the same objective may also be used.

One hundred year flood level:

For the shorelines of the Great Lakes, the peak instantaneous level resulting from combinations of mean monthly lake levels and wind setups, which has a 1% chance of being equalled or exceeded in any given year.

Other water-related hazards:

Water associated phenomena other than flooding and wave uprush which act on shorelines. This includes, but is not limited to ice, ice piling, ice jamming, as well as the impacts of wakes from passing boats.

Protection works standards:

The combination of non-structural or structural works and allowances for slope stability and flooding/erosion to reduce the damage caused by flooding hazards, erosion hazards and other water-related hazards, and to allow access for their maintenance and repair.

Redevelopment: means the creation of new units, uses or lots on previously developed land in existing communities, including *brownfield sites*.

Site alteration:

Activities, such as grading, excavation and the placement of fill that would change the landform and natural vegetative characteristics of a site. Placing fill and altering local drainage is a site alteration.

Wave Uprush:

The rush of water up onto a shoreline or structure following the breaking of a wave; the limit of wave uprush is the point of further landward rush of water onto the shoreline.

1.0 Introduction

The Municipality of Lakeshore has embarked on a new project to develop a Shoreline Management Plan for the Lake St. Clair shoreline, map flooding, erosion, and dynamic beach hazards, and develop management and policy recommendations to increase resilience. Lake St. Clair water levels were recently at an all-time high, and extreme weather events are anticipated to increase in severity. The Municipality of Lakeshore feels that this is an opportune time to begin discussions with stakeholders to create a long-term management plan to address existing and future risks to public health and property and to conform with applicable Provincial Policy direction. Additionally, this plan will investigate how similar shorelines manage the risks associated with coastal hazards and provide high-level recommendations for proactive land use planning with the Municipality.

In 2019, the Province of Ontario released its Independent Review of Flood Events in Ontario (McNeil Consulting Inc. and MNRF, November 2019). One of the recommendations of the review included a call for all levels of government to:

> work with the Essex Region Conservation Authority and the Lower Thames Valley Conservation Authority to undertake a coordinated short- and long-term strategy to address the existing and expected impacts [in the area] as a result of current and future water levels, flood and erosion hazards, and climate change on Lake Erie, Lake St. Clair, and the Detroit River (MacNeil Consulting Inc., November 2019).

In response to the Independent Review, the Ontario Government released: Protecting People and Property: Ontario's Flooding Strategy (MNRF, 2020). The Strategy identifies a number of priorities and a range of actions to be initiated over the next several years, including:

- Creating enhanced floodplain mapping;
- Increasing public awareness and education of coastal risks;
- Regulatory and policy reviews;
- Updating current technical guidance for hazard delineation;
- Enhancing response and recovery; and,
- Investing in flood risk reduction.

The Shoreline Management Plan (SMP) supports the recommendations of the Flood Events in Ontario Report (McNeil and MNRF, 2019) and the objectives of Ontario's Flooding Strategy (MNRF, 2020), and acknowledges that the current policy and regulatory framework is changing. A proactive approach to mapping coastal hazards and identifying management strategies to reduce risks is necessary to better position

the Municipality of Lakeshore to update planning regulations and implement infrastructure projects to mitigate the impacts of future flooding events.

1.1 Purpose and Background

The entire northern extent of the Municipality of Lakeshore consists of the Lake St. Clair shoreline and includes both serviced and unserviced development areas. Each reach of the shoreline is exposed to shoreline hazards, such as flooding and erosion.

Currently, the Municipality of Lakeshore does not have a shoreline management plan for the entire reach of shoreline within the boundary of the municipality. The Essex Region Conservation Authority (CA) has been using flood line and erosion data produced in 1976 to regulate development activities along the Lake St. Clair shoreline, through O. Reg. 158/06. The Lower Thames Valley Conservation Authority (LTVCA) also regulates a portion of the shoreline within the study area, including the Lighthouse Cove community, through O. Reg 152/06 which came into force in 2006. Lighthouse Cove is also regulated for Thames River flooding through R.R. O. 1990, Reg. 155.

Due to these old regulations and hazard mapping, the establishment of a new record high lake level in 2019, lack of climate change considerations, and continued development on hazardous lands, the Municipality of Lakeshore is in need of updated land use policies, strategies to de-risk existing developments, and a long-term management plan to increase the resilience of the Lake St. Clair shoreline into the future.

1.2 Study Limits & Approach

The SMP includes technical analysis of erosion and flooding hazards associated with the Lake St. Clair shoreline within the Municipality of Lakeshore limits and the identification of land use policies, strategies, and engineering solutions to better protect the shoreline areas from coastal risks. It should be noted that the SMP is limited to assessing shoreline hazards. There are areas within the Municipality that are also subject to inland and riverine flood hazards, and while these hazard areas may overlap in cases, the SMP is solely focused on the identification of shoreline hazards along Lake St. Clair. These shoreline hazards consist of the 100-year flood level, plus allowances for wave uprush, 100 years of shoreline erosion, and dynamic beach hazards.

The SMP has regard for the following concepts and management strategies:

- **Avoid** – new development shall be directed away from hazardous lands.
- **Accommodate** – when existing development is threatened by coastal hazards, site modifications such as raising building foundations or increasing the crest elevation of existing shoreline protection can reduce risks.

- **Retreat/Re-align** – in high risk communities, relocation of vulnerable assets can be a viable management strategy. In some cases, this may involve long-term land acquisition strategies. Re-aligning land uses and restoring hazardous lands with nature is often combined with retreat strategies.
- **Protect** – when existing development is threatened by natural hazards, structural measures such as shoreline protection can be constructed to decrease vulnerability to flooding and erosion;
- **Emergency Response** – recommendations will be provided for emergency response based on the technical analysis, such as the flood hazard mapping.
- **Public Information** – increased awareness of challenges and risks associated with shoreline hazards;
- **Environment** – ensure that no adverse environmental impacts result from the recommended actions; and,
- **Monitoring** – Evaluate future flood and erosion events, vulnerable infrastructure, and economic damages associated with coastal storms. The implementation of the Shoreline Management Plan recommendations and their effectiveness at mitigating future risks should also be evaluated.

Figure 1.1 Study Area

1.3 Plan Objectives

The primary objectives for the Plan are to:

1. Adopt a balanced approach for all coastal management decisions that strikes a balance between new shoreline uses and site alterations, socio-economic considerations (e.g., public access to the lake), and protection and enhancement of shoreline habitats and environmental assets.
2. Provide recommendations to minimize danger to life and property damage from flooding, erosion, and associated hazards along the shoreline.

3. Ensure that future shoreline development is directed away from hazardous lands.

4. Reflect current provincial policy direction as it applies to shoreline development and shoreline management. The Provincial Policy Statement directs land use planning authorities to ensure that no new hazards are created with new development; existing hazards are not aggravated; and adverse environmental impacts do not result.

5. Provide management recommendations on a reach by reach basis to address existing coastal risks such as flooding and erosion, emergency response challenges during road and building flooding, and upgrades to existing shoreline protection structures.

1.4 Area Characterization

The shoreline within the boundaries of the Municipality of Lakeshore is highly developed, with a number of predominantly residential settlement areas (from east to west): Lighthouse Cove, Stoney Point/ Pointe aux Roches, Rochester Place/Deerbrook, Belle River, Maidstone/Emeryville, and Russel Woods. Development along the shoreline is predominantly residential, but also includes some recreational areas, including marinas, community parks, commercial areas, a historic lighthouse in Lighthouse Cove, and several natural areas including wetlands. There are currently a range of shoreline protection measures in place, which include steel sheet pile walls, concrete seawalls, pre-cast concrete blocks, and armourstone revetments.

There are a number of significant natural heritage features along the shoreline and within tributaries and human-made canals, including coastal wetland complexes, spawning, nursery and foraging habitats for a diversity of warmwater fish species, and habitat for a variety of fish and mussel specifies at risk (Municipality of Lakeshore Official Plan, March 2021). A large number of significant terrestrial wildlife habitats are also present throughout the shoreline and surrounding areas.

As noted in the objectives, protecting these natural heritage features along the shoreline is an important component of the SMP, as is increasing the resilience of the built environment to coastal hazards. These objectives are discussed further in Section 5.0 (shoreline management) for the seven reaches delineated for the study. Refer to Section 5.1 for additional details on the reach boundaries and delineation approach. Recommendations for upgrades to existing shoreline protection are provided, along the reach specific approaches to decrease coastal risk.

1.4.1 Mapping & Data Collection

Data collection, including images of the shoreline collected from a drone and water depth surveys were completed by Zuzek Inc. in Phase 1 of the study. This information was used to prepare a database of shoreline protection measures along the shoreline.

Also, it was used as the basis for technical assessment and modelling completed during Phases 2 and 3 of this study.

2.0 Planning Policy & Legislative Authority

2.1 Provincial Policy Statement

The Provincial Policy Statement (PPS), 2020 released by the Ministry of Municipal Affairs and Housing (MMAH) came into force and effect on May 1, 2020, and provides key policy direction associated with land use and development throughout the province. The PPS sets the policy foundation for regulating the use of lands and supports the provincial goal to enhance the quality of life for all Ontarians. The intent is to provide for appropriate development while protecting resources of provincial interest, public health and safety, and the quality of the natural and built environment.

It should be noted that the local Official Plans represent the most important vehicle for implementing the policy direction within the PPS. Since the SMP is intended to support the Municipality's Official Plan Review and Update, it provides the opportune time to incorporate the updated policy direction from the 2020 PPS. The sections below provide a summary of the provincial policy direction within the PPS 2020. Notes have been provided when these policies differ from the previous 2014 PPS.

2.1.1 Building Strong Healthy Communities (PPS 1.0)

Section 1.0 of the PPS outlines that efficient land use and development patterns support sustainability by promoting strong, liveable, healthy, and resilient communities. Accordingly, healthy, liveable and safe communities are sustained by avoiding development and land use patterns which may cause environmental or public health and safety concerns; promoting cost-effective development patterns and standards to minimize land consumption and servicing costs; and promoting development and land use patterns that conserve biodiversity and consider the impacts of a changing climate.

Furthermore, the PPS recognizes that the vitality of settlement areas is critical to the long-term economic prosperity of our communities. In the interest of all communities, land and resources should be used wisely, efficient development patterns should be promoted, resources and green spaces should be protected, and infrastructure and public service facilities should be effectively used. These principles should be incorporated into the land use patterns of all settlement areas to minimize unnecessary public expenditures related to poor planning (e.g., new development located on a coastal floodplain).

Rural areas are also important to the economic success of the Province and contribute to quality of life. They play an integral role with their surrounding settlement areas in the creation of interdependent markets, resources, and amenities. Leveraging these rural assets and amenities is important, as is protecting the environment as a foundation for a sustainable economy. Therefore, integrated and viable rural areas should be supported by conserving biodiversity and considering the ecological benefits provided by nature, as well as providing opportunities for sustainable and diversified tourism, including those that leverage cultural and natural assets. In rural areas, the PPS notes that “rural settlements areas shall be the focus of growth and development and their vitality and regeneration shall be promoted” (PPS 2020, 1.1.4.2). When directing development in these areas, consideration should be given to “rural characteristics, the scale of development and the provision of appropriate service levels” (PPS 2020, 1.1.4.3). Most of the rural areas along the shoreline feature agricultural lands and are highly floodprone. Further conversion of these agricultural lands should be avoided to preserve the agricultural economy.

Coordination when dealing with planning matters is also a requirement of the PPS. According to PPS 2020, 1.2.1 e) and f), for matters relating to the ecosystem, shoreline, watershed, and the Great Lakes, and matters related to natural and human-made hazards, a coordinated, integrated and comprehensive approach should be utilized. These matters should be integrated across municipalities, with other levels of government, and the applicable agencies and boards.

Shoreline management relates to other policies of the PPS, including its integration with recreation, parks and open spaces. PPS 2020 1.5.1 recognizes that healthy, active communities should be promoted by “planning and providing for a full range and equitable distribution of publicly accessible built and natural settings for recreation, including, … where practical, water-based resources”, as well as “providing opportunities for public access to shorelines”. Unfortunately, much of the Lakeshore shoreline has been converted to private residential land and public access to the lake is limited. The few remaining natural areas and conservation lands are highly floodprone and often feature an eroding shoreline. Investing in these publicly available natural assets would be consistent with the PPS.

Other provincial policy addresses the planning for sewage and water services, requiring that growth is directed and accommodated in a manner that promotes the efficient use and optimization of existing services, can be sustained by the water resources upon which such services rely, is feasible and financially viable, and protects human health and the natural environment. Municipal water and municipal sewage services are the preferred form of servicing for settlement areas (PPS 2020, 1.6.6.2). It is a requirement under provincial policy that planning for servicing be integrated with land use considerations at all stages of the planning process (PPS 2020, 1.6.6.1). The use of on-site sewage services (e.g., private septic systems) for individual lots is addressed in Section 1.6.6.4, including use only when site conditions are appropriate and there are

no negative impacts. The potential threat to the safe operation of sewage services during coastal flooding is discussed in Section 5.0. This integration of considerations is therefore part of shoreline management planning.

Updates within the 2020 PPS also mandate that infrastructure systems be provided in a manner that "prepares for the impacts of a changing climate" (PPS 2020, 1.6.6.1. b). The change in wording within the 2020 PPS focuses on requiring municipalities to prepare for "the *impacts of a changing climate*" through land use and development patterns and infrastructure systems. These impacts would be defined as "the present and future consequences and opportunities from changes in weather patterns at local and regional levels including extreme weather events and increased climate variability" (PPS 2020, 6.0). Historical lake level extremes were summarized in Section 3.2.3 and projected climate change impacts were discussed in Section 3.2.5. The flood hazard limit was mapped throughout the Municipality of Lakeshore using the historical 100-year lake level and sensitivity analysis was completed in three locations where the 100-year climate change lake level was also mapping. Refer to Sections 4.2 to 4.4 for additional details on the flood hazard mapping.

2.1.2 Wise Use and Management of Resources (PPS 2.0)

Section 2.1 of the PPS speaks to Natural Heritage and requires natural heritage systems to be identified in various Ecoregions. Development and site alteration is not permitted in the following designated features (within Ecoregion 7E applicable to the Municipality of Lakeshore): significant wetlands and significant coastal wetlands (PPS 2020, 2.1.4).

Development and site alteration is not permitted in the following features, unless it has been demonstrated that there will be no negative impacts on the natural features or their ecological functions: significant woodlands, significant valleylands, significant wildlife habitat, significant areas of natural and scientific interest, or coastal wetlands that are not subject to policy 2.1.4 above (PPS 2020, 2.1.5).

Development and site alteration shall not be permitted in the following features, except in accordance with provincial and federal requirements: habitat of endangered or threatened species, and fish habitat (PPS 2020 2.1.6 and 2.1.7).

The flood and erosion threats to the few remaining coastal wetlands, such as those found at Ruscom Shores Conservation Area and Tremblay Beach Conservation Area, are discussed further in the Reach summarizes in Appendix F.

2.1.3 Protecting Public Health and Safety (PPS 3.0)

The provincial direction on natural hazards focuses on reducing the potential for public cost or risk to Ontario's residents, and thereby directing development away from areas

of natural or human-made hazards. As such, "development shall generally be directed, in accordance with guidance developed by the Province (as amended from time to time), to area outside of *hazardous lands* adjacent to the shoreline of the Great Lakes and other large inland lakes that are impacted *by flooding hazards, erosion hazards* and/or *dynamic beach hazards"* (PPS 2020, 3.1.1). It should be noted that the reference to guidance developed by the Province was not included in the 2014 PPS, and likely refers to the existing technical guidance documents.[1]

The intent of Section 3.0 of the PPS is to locate new development away from areas where there is an unacceptable risk to public health or public safety or risk of property damage. Development shall also not occur in areas where there is risk of creating or aggravating existing hazards.

More explicitly, the PPS does not permit development, which is defined as the creation of new lots, a change in the use of land, or any construction that requires approval under the Planning Act (e.g., a minor variance, draft plan of subdivision, part lot control, etc.) on lands within the following types of natural hazards:

- *Dynamic beach hazards*;
- *Defined portions of the flooding hazard along connecting channels* (the Detroit River included);
- Areas that would be rendered inaccessible to people and vehicles during times of *flooding hazards*, *erosion hazards* and/or *dynamic beach hazards*, unless it has been demonstrated that the site has safe access appropriate for the nature of the use in question and the natural hazard; and,
- A *floodway* regardless of whether the area of inundation contains high points of land not subject to flooding.

As discussed in Section 4.3 and 5.3, plus the Reach summarized in Appendix F, a significant portion of the shoreline development in Lakeshore is located on hazardous lands and features road flooding depths greater than 0.3 m, raising serious concerns about ingress and egress during a the 100-year lake level. Furthermore, in accordance with the PPS, the following uses are not permitted on *hazardous lands:*

- Institutional uses including hospitals, long-term care homes, retirement homes, pre-schools, school nurseries, day cares and schools;
- Essential emergency services such as those provided by fire, police and ambulance stations and electrical substations; or,

[1] E.g., Technical Guide: Great Lakes-St. Lawrence River System Tech Guide, 2001, MNRF.

- Uses associated with the disposal, manufacture, treatment or storage of hazardous substances.

Not withstanding the above, development may be accommodated within portions of hazardous lands where the effects and risk to public health and safety are minor, can be mitigated in accordance with Provincial standards, and where all the following criteria are demonstrated and achieved:

- The *development* and *site alteration* (e.g., the change in use as well as the construction process) is carried out in accordance with *flood proofing standards, protection works standards*, and *access standards*;
- Vehicles and people have a way of safely entering and exiting the area during times of flooding, erosion and other emergencies;
- New hazards are not created, and existing hazards are not aggravated; and
- No adverse environmental impacts will result (PPS 2020, 3.1.7).

Based on the spatial extent of the flooding for the 100-year lake level and the additional risks posed by a changing climate, it is not clear the policy mechanisms that have permitted newer developments in Lakeshore's hazard areas. When the above criteria can be satisfied, this type of development is carried out through additional guidance outlined in municipal policy, specifically the policies contained within the Municipality of Lakeshore Official Plan described in Section 2.3 below.

2.2 County Official Plan

The Municipality of Lakeshore falls under the upper-tier municipality of the County of Essex. The purpose of the County Official Plan (COP) is to establish a policy framework for managing growth, protecting resources and providing direction on land use decisions during the planning period up to and including 2031. The intent is to implement the PPS at the County level and provide guidance and direction to the seven local municipalities, including the Municipality of Lakeshore, in their preparation and future implementation of Official Plans (OP), OP amendments and Zoning By-laws. Some of the Plan's key goals for a healthy County are to "protect life and property by directing development away from natural and human-made hazards" and to ensure that Lake St. Clair is noted as a significant area "for fishing and hunting and that future land use decisions are made with regard to maintaining access to these resources".

Section 2.4 of the COP outlines the policies related to flood and erosion (natural hazards). It is a policy of the COP to identify the Lake St. Clair floodprone areas as

being susceptible to *flooding* and *erosion hazards* and sets the regulatory flood standard for flood plains. From this, the local municipalities must identify areas susceptible to flood and/or erosion along areas of Lake St. Clair, as well as the other major waterways, in consultation with local Conservation Authorities. The COP dictates that local Municipalities, including the Municipality of Lakeshore, establish policies in their local Official Plans that direct *development* outside of areas susceptible to flooding and/or erosion and further identify these areas in local Zoning By-laws. Also, for development and site alteration that may be permitted within the areas identified as being susceptible to flooding and/or erosion, the County sets out specific criteria. The COP requires that dynamic beaches are identified in local OPs, in consultation with the applicable CA, to conserve and safeguard the natural ecosystem, tourism potential, adjacent land uses and related public safety.

For development fronting on the Lake St. Clair shoreline, the County requires that the Municipality of Lakeshore establish policies and regulations that provide development setbacks, elevations and shoreline protection measures. Setbacks are the preferred method for protecting new development as opposed to relying on structural or non-structural protection measures that require maintenance and upgrading over time. At the County level, the OP policies commit Essex to exploring opportunities for longer term solutions to recurring flooding where existing development exists within shoreline floodprone areas. The County will support the preparation of detailed studies, such as the Municipality of Lakeshore Shoreline Management Plan, to identify and define natural hazard areas for streams, rivers, lakefronts and connecting channels. These studies will be undertaken to conserve *natural heritage features* and the *natural heritage system*, capitalize on tourism potential, protect adjacent land uses, and enhance public safety (Section 2.4.1 h)).

It is the intent of the Shoreline Management Plan to recommend land use planning controls, including recommendations for land use and zoning updates, that may result in updates to the Section 2.4 policies of the COP.

2.3 Municipal Official Plan

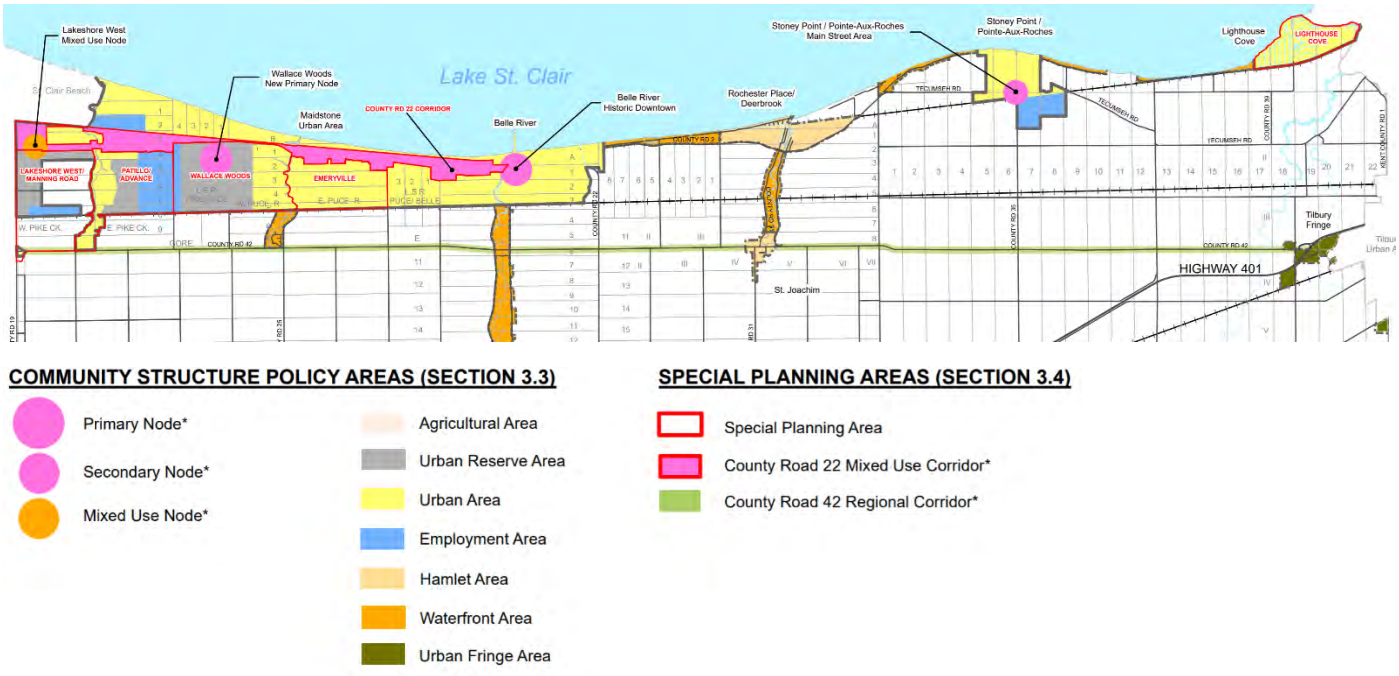
In accordance with the Planning Act, and implementing provincial policy, the Municipality of Lakeshore Official Plan (OP) establishes the goals, objectives, and policies to support the creation of strong communities, the wise use and management of resources, and the protection of public health and safety. It identifies the Municipality's strategic direction within the applicable requirements set out in provincial policy and County-wide policy, as expressed in the Essex County Official Plan. The local OP manages and directs physical change and is designed to promote the vital link between the community, the economy, and the natural environment.

It should be noted that the Municipality is currently undertaking a five-year review of the OP. It is intended that the SMP will provide guidance with respect to revised shoreline hazard mapping and any needed changes to the Official Plan policies.

A key planning objective of the OP is to foster growth and development that is naturally inviting and environmentally aware. The Municipality accommodates a variety of significant natural features and environments that provide ecological, cultural and recreational benefits. It is the desire of the Municipality to protect and expand these natural systems to promote the creation of a linked system of features, and their ecological functions. Additionally, the OP identifies a strategic direction to "direct development away from natural and human-made hazards and flood and erosion hazards" (2.3.6 d).

A key component of the OP is managing where and how to grow in a manner that accommodates the Municipality's projected population and employment growth, while protecting the County's agricultural, rural and natural resources. The fundamental community structure and guidance for long-term growth is guided by Schedule "A" – Community Structure. **Figure 2.1** shows the Municipality of Lakeshore Shoreline Management Plan Study Area as it related to the community structure polices areas of Schedule "A" (see Appendix C).

Figure 2.1 Schedule "A" Community Structure



Along this stretch of the southern coast of Lake St. Clair, there are multiple land use types present. Much of the shoreline is designated as a Waterfront Area, which is to

accommodate predominately existing residential, commercial, recreational and open space and related uses. Limited growth may be accommodated through infill and development of vacant lands in accordance with all applicable policies for servicing, natural heritage and hazard lands. The Municipality will also promote opportunities for public access to the waterfront and the development of a waterfront trail system.

Urban Areas are also seen along the shoreline, extending inland – in some cases, as far south as the existing rail line. These designations are some of the largest urban areas in the Municipality of Lakeshore and function as the Municipality's focal point for growth, development and urban activities.

Other land use designations include Hamlet Areas, which are small rural settlements that provide limited services to the surrounding agricultural community, and which are expected to experience only minor infill and development of vacant lands, as appropriate.

The County Road 22 Mixed Used Corridor is envisioned as a higher intensity mixed use corridor extending across the Maidstone and Belle River Urban Areas. The corridor is anticipated to accommodate a combination of commercial, retail and residential uses through infilling, intensification and redevelopment, and the development of vacant and underutilized lands.

There are areas of extensive development along the shoreline, in some cases where natural hazards are present. In these areas, the policy notes that a reasonable compromise will be made between the extent of the hazard and the continued use and future development of the area (Section 5.4.1). The situation is particularly applicable to the Urban Areas, Hamlet Areas and Waterfront Residential Areas. The Zoning By-law may establish specific zones to address existing development locations within this area.

2.3.1 Special Planning Areas

Six (6) Special Planning Areas have been identified in the Municipality's OP, based on the desired growth management framework. It is generally intended that secondary plans may be prepared for these areas to comprehensively address future land use patterns for new development areas or to implement a specific planning initiative. If a Special Planning Area falls within the Shoreline Management Study Area, any future secondary planning for the area should consider the recommendations and updated mapping resulting from this study and other applicable hazard investigations (e.g., riverine floodplain mapping). The Special Planning Areas include the following locations:

- Emeryville
- Patillo/Advance
- County Road 22 Corridor
- Wallace Woods

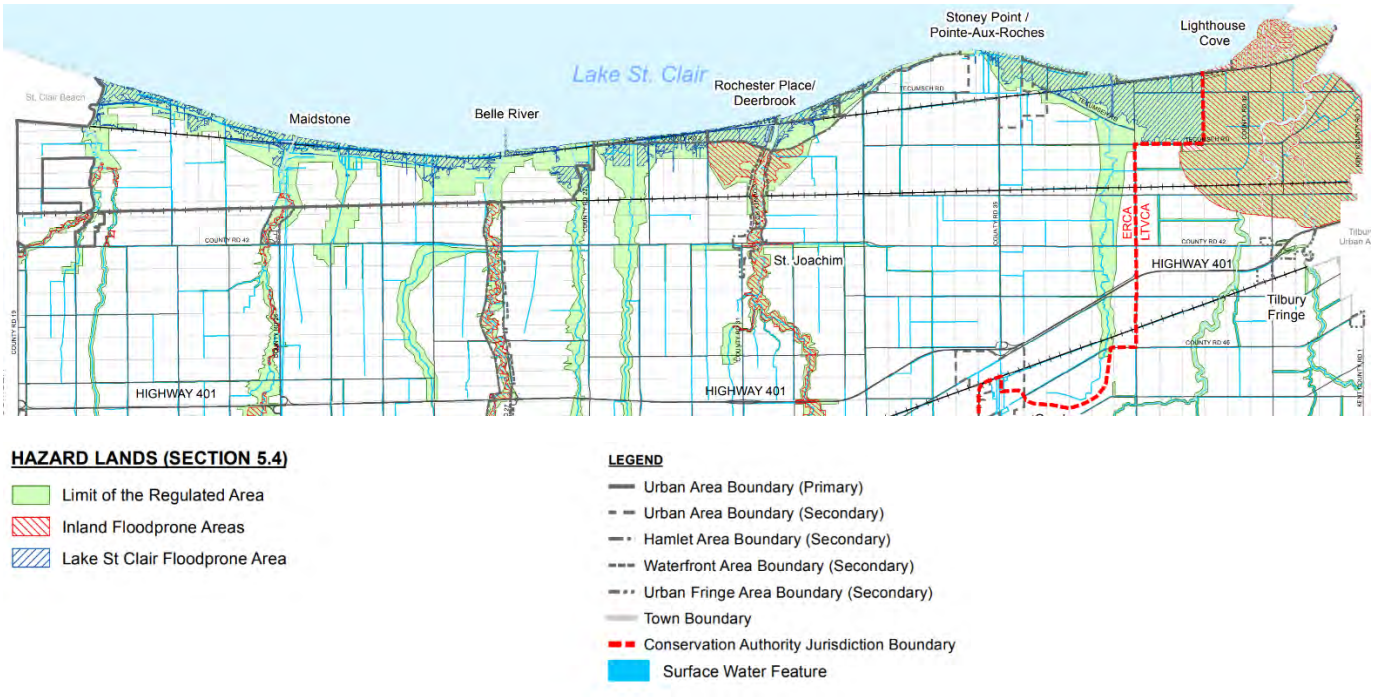
- Lakeshore West/Manning Road
- Lighthouse Cove

2.3.2 Official Plan Hazard Policies

It is a priority of the Municipality to ensure the sustainable use of resource assets, to protect and enhance significant natural features and functions, and to reduce the risk to public safety and property from hazards, such as flooding, unstable slopes and human-made hazards. Section 5.4.1 of the Municipality's OP outlines the intent of the Municipality to protect life and property by respecting natural and human-made hazards, which may represent constraints to development.

The policies regarding natural hazards are to be applied when determining uses permitted on lands identified as Hazard Lands and illustrated as: the Limit of the Regulated Area; Lake St. Clair Floodprone Areas; and, Inland Floodplain Control Areas, as shown on Schedule "B.4" of the Municipality's OP. **Figure 2.2** shows the extent of the Municipality's shoreline outlining its old Natural Hazards and Floodprone Areas. This mapping should be updated with the technical findings of this study.

Figure 2.2 Schedule "B.4" Natural Hazards and Floodprone Areas



Section 5.4.1.1 of the Municipal OP outlines the applicable policies for the Limit of the Regulated Area (LORA), which requires that appropriate arrangements be made with the appropriate conservation authority prior to permitting development. Within the LORA lands, policies for “Inland Floodprone Area” or “Lake St. Clair Floodprone Area” may also apply.

It should be noted that these areas are referred to differently between the OP Schedules and Text, which may cause confusion. The OP Schedules refer to “Inland Floodprone Areas” and “Lake St. Clair Floodprone Area”, while the text of the OP policies refer to “Inland *Floodplain Development Control Area*” and “Lake St. Clair *Floodplain Development Control Area.*” The current Official Plan Review process, along with this SMP provide the opportunity to revise these policies to ensure consistency.

Inland Floodprone Area/Inland Floodplain Development Control Area policies (Section 5.4.1.2) require that development on these lands, other than lands in the floodway, may only be permitted if the existing or potential hazards can be overcome by accepted engineering techniques and resource management practices, such as those set out by Provincial technical manuals. Additionally, the Municipality must consider the economic, social and ecological costs and benefits of any engineering works or resource management practices needed to overcome the impacts. Furthermore, any new development must meet minimum flood protection standards, and appropriate vehicular access routes are to be maintained. Lastly, as required by provincial policy, certain uses are prohibited in Hazard Lands which include: any uses involving hazardous substances or sewage; institutional uses (schools, nursing homes, etc.); emergency services or electrical substations.

Lake St. Clair Shoreline Floodprone Area/Floodplain Development Control Area policies, as outlined in Section 5.4.1.3 of the OP, note that buildings are required to be floodproofed to protect them from lake-related flooding. An appropriate setback from the defined shoreline of the Lake may also be required to protect the building from wave uprush and other water related hazards. Generally, the policies state that development should be directed outside of the furthest landward limit of the dynamic beach hazard limit, the flood hazard limit, and the erosion hazard limit. Similar to the inland floodprone areas, development would not be permitted in areas that would be rendered inaccessible to people and/or vehicles during a time of hazard events unless it is demonstrated that the site has safe access. Any development in the dynamic beach hazard would also not be permitted. The following uses are also prohibited: any uses involving hazardous substances or sewage; institutional uses (schools, nursing homes, etc.); emergency services or electrical substations.

Despite these restrictions, development in the Lake St. Clair Shoreline Floodprone Area may be permitted in some circumstances. In consultation with the CA, and where the risks can be absorbed, managed or mitigated in accordance with the Municipality’s standards, development may be permitted. The Municipality’s standards include:

- Safely addressing the hazards, and ensuring that development is completed in accordance with floodproofing standards, protection works standards, and access standards;
- Existing hazards are not aggravated or new hazards are not created;
- No adverse environmental impacts will result, and no negative impacts on Natural Heritage Features will result;
- Vehicles and people have a way of safe ingress and egress during times of flooding, erosion or other emergencies; and,
- Development is carried out in accordance with established standards and procedures.

Existing development and land uses are also addressed in the Lake St. Clair Shoreline Floodprone Area policies of the OP. The Municipality commits to undertaking studies in cases of severe water and erosion damage to the Municipal roads or other public property (Section 5.4.1.3. e). These studies aim to compare the costs of erosion abatement with structure relocation, road closing and/or relocation, or the acquisition of new properties. Alternatives will be considered prior to any erosion abatement scheme or other course of action being taken. Repairs and minor additions may be permitted to existing non-conforming development, subject to applicable regulations (Section 5.4.1.3. f). Replacements to existing buildings or structures may be permitted provided it does not result in an increase in the original usable floor area or alter the original use or affect shoreline processes (Section 5.4.1.3. g).

There may be areas where the hazard needs to be addressed on a more comprehensive basis, rather than on an individual lot by lot basis (Section 5.4.1.3. h). This is discussed further in Section 5.0. Therefore, a more comprehensive review of the particular hazard may need to be evaluated prior to replacing a building or structure. Nothing in the policies for the Lake St. Clair Shoreline Floodprone Area should be interpreted to prohibit the relocation of an existing building or structure presently located within the erosion hazard limit further from the hazard (e.g., the top of bank) even if it is still in the erosion hazard limit.

In accordance with the Zoning By-law, the applicable Conservation Authority has jurisdiction for hazard issues within the Limit of the Regulated Area (LORA). The permitting authority of a CA is outlined in Section 28 of the Conservation Authorities Act (CAA), R.S.O 1990, C.C.27, as amended. As the Municipality’s shoreline covers two conservation authority boundaries, specific regulations of the CAA apply to Lakeshore’s two watersheds.

2.4 Conservation Authorities Act

All lands within the Limit of the Regulated Area are regulated by the "Development, Interference with Wetlands and Alteration to Shoreline and Watercourses Regulations" under the Conservation Authorities Act. As such, the relevant Conservation Authority should be contacted when proposing development within or near the lands identified on Schedule "D.4" as the Limit of the Regulated Area, which encompasses three principal hazards: riverine hazards, shoreline hazards and other hazards (i.e., ice jams).

2.4.1 Ontario Regulation 97/04 and 158/06, and 152/06

Ontario Regulation 97/04 under the Conservation Authorities Act (CAA) is more commonly known as the "Development, Interference with Wetlands and Alteration to Shoreline and Watercourses Regulations" which generally outlines a Conservation Authorities' (CA) ability to regulate hazards under Section 28 of the CAA. Ontario Regulation 158/06 (Essex Region CA) and 152/06 (Lower Thames Valley CA) provide more detail on each applicable conservation authorities ability to regulate hazards within the study area. At any given location in the Municipality of Lakeshore, two of the CAA regulations apply to a specific geography: a. the general O. Reg 97/04; b. either O. Reg 158/06 or O. Reg 152/06, depending on the watershed that the site falls within.

It should be noted that there have been recent changes to the Conservation Authorities Act (CAA) through both Bill 139 – Building Better Communities and Conserving Watersheds Act (2017), and Bill 108 – More Homes, More Choice Act (2019).

The general content and authority of Ontario Regulation 97/04 prohibits development in or on: hazard lands, wetlands, areas adjacent or close to the shoreline of Lake St. Clair, including the area from the furthest offshore extent of the authority's boundary to the furthest landward extent of the boundary, based on distances that are outlined in the regulation. These distances, and therefore the "regulated area", can change based on the presence of certain hazards that can exist along the shoreline (e.g., dynamic beaches). The Regulated Area under the CAA is defined by the hazard mapping standards outlined in the Technical Guide (MNR, 2001) and the Guidelines for Developing Schedules in Regulating Areas (CO and MNR, 2005) documents used in implementing the policies of the PPS.

O. Reg 158/06 applies to lands within the watershed boundary of the Essex Region CA.

O. Reg 152/06 applies to lands which fall within the watershed boundary of the Lower Thames Valley CA.

While the CAA and the accompanying Regulations represent a regulatory and permit process separate from the land use planning process, they have an important relationship – the land use planning system, governed by the *Planning Act,* PPS, and implemented through local Official Plans and Zoning Bylaws, should adequately

consider and plan for these hazard areas such that a Section 28 Permit can be granted at the time of building.

2.5 Canada-Ontario Agreement on Great Lakes Water Quality and Ecosystem Health

The Great Lakes, along with its inland waterways are seen as the foundation of Ontario's economic prosperity and well-being, as they supply water, support the Province's economy and provide healthy ecosystems for recreation and tourism. As such, the Province undertakes continued negotiations and partnership with the federal government under agreements such as the Canada-Ontario Great Lakes Agreement, to continue to support the health of the Great Lakes.

The agreement supports the ongoing restoration of the water quality and ecosystem health in designated areas of the Great Lakes. As outlined in the Preamble to the Provincial Policy Statement, there may be circumstances where planning authorities should consider agreements related to the protection or restoration of the *Great Lakes – St. Lawrence Basin*, such as those between Ontario and Canada.

This Shoreline Management Plan will have regard for the Canada-Ontario Great Lakes Agreement, and recommendations should ultimately contribute to the overall goal of supporting the ecosystems and water supply provided by Lake St. Clair.

2.6 Policy Summary

There is strong provincial and municipal policy support and mandate to assess and delineate shoreline hazards and their impact on existing and future development in Ontario. The recent changes in the PPS, including the requirement for municipalities to "prepare for the impacts of a changing climate" recognizes that existing hazards, such as flooding, will get worse in the future. It will continue to present significant challenges to all communities, including the Municipality of Lakeshore, where a significant portion of the population and developed area are already located on floodprone lands based on historical extremes. The amount of vulnerable infrastructure and potential economic damages associated with future flooding will increase due to climate change.

Unfortunately, at the time of this report preparation, there was no technical guidance from the Province of Ontario for integrating the impacts of a changing climate into coastal hazard mapping. Therefore, the hazard mapping prepared for this report was based on historical flood levels and erosion rates. A sensitivity analysis of future flooding potential due to climate change was completed at three locations and is summarized in Section 4.4 and Appendix E.

The mapping, technical assessment, modeling, and policy recommendations that result from this SMP must be coordinated and fully integrated with ongoing considerations for land use, development and future economic growth, recreational and cultural heritage assets, and municipal infrastructure systems. It must also be well integrated with the legislation and directives of the two Conservation Authorities having jurisdiction.

The SMP will make policy recommendations for the Lakeshore Official Plan to achieve greater consistency with the Municipality's existing Natural Hazard Policies and will make new recommendations for land use policies and adaptation strategies to increase resilience to coastal hazards. Furthermore, specific and targeted policy recommendations for re-development along the shoreline will be provided in Section 5.4.

3.0 Analysis

Section 3.1 and 3.2 summarizes the data collection and technical analysis completed for the SMP by Zuzek Inc. Section 3.3 provides an analysis of land use planning approaches from various municipalities in Ontario, as well as other Provinces, completed by Stantec Consulting Ltd. to inform the recommendations of this SMP.

3.1 Data Collection

The oblique drone photography, nearshore water depths, and building footprints collected for the study are described.

3.1.1 Oblique Photographs from a Drone

Oblique photos were collected with a drone for the entire 33-kilometre (km) project shoreline in September 2019. The purpose of capturing the aerial photography was to develop a current, georeferenced, photographic library of the entire shoreline. This library was the primary source of information for the development of a high-resolution shoreline protection database (refer to Section 3.2.1). It also provided the project team with the ability to view and assess portions of the shoreline that would have been logistically difficult to reach by land.

The drone featured a built-in camera with a 12.7-megapixel sensor, three-axis image stabilization and geotagging capabilities. Photographs were generally taken from an elevation of approximately 35 metres (m), a horizontal distance of approximately 60 m offshore, and with shore-parallel spacing of individual images on the order of 20 – 30 m. This allowed for complete shoreline coverage with sufficient overlap in adjacent photos while producing images with high enough resolution to assess the condition of shoreline structures at the individual private property scale. Where appropriate, images were captured from a higher elevation and further offshore to provide an increased range of view. Sample photographs captured using the drone are provided in Figure 3.1.

Figure 3.1 Lakeshore Oblique Drone Photography

3.1.2 Nearshore Water Depth Survey

The SOLIX is a single-beam depth sounder and sonar system with built-in recording and navigation tools. The transducer was mounted at the back of a boat with a dedicated GPS antenna located directly above the unit. The unit auto-corrects for the depth of the transducer below the lake surface. Depths were recorded every second. A picture of the navigation screen is provided in Figure 3.2. The extent of the data coverage is presented in Figure 3.3.

Figure 3.2 SOLIX Navigation Screen

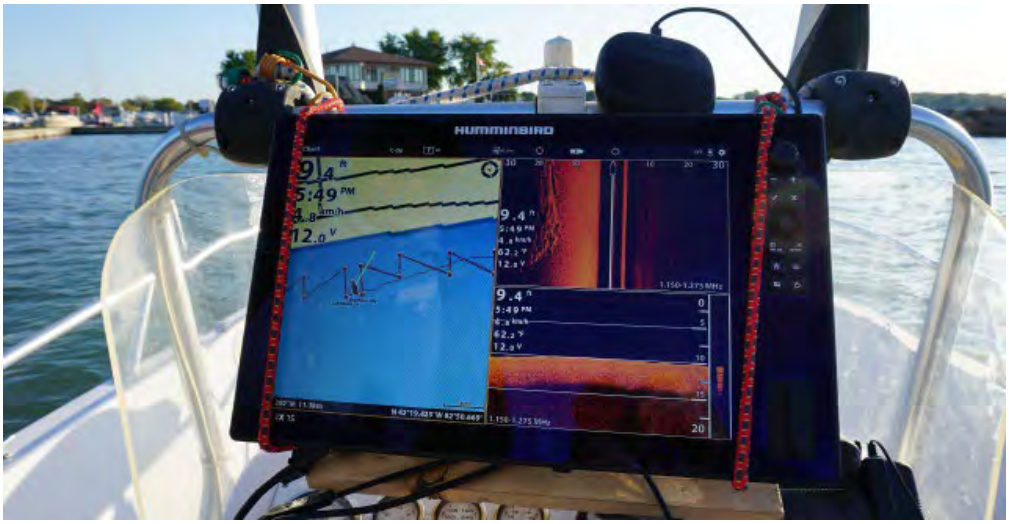
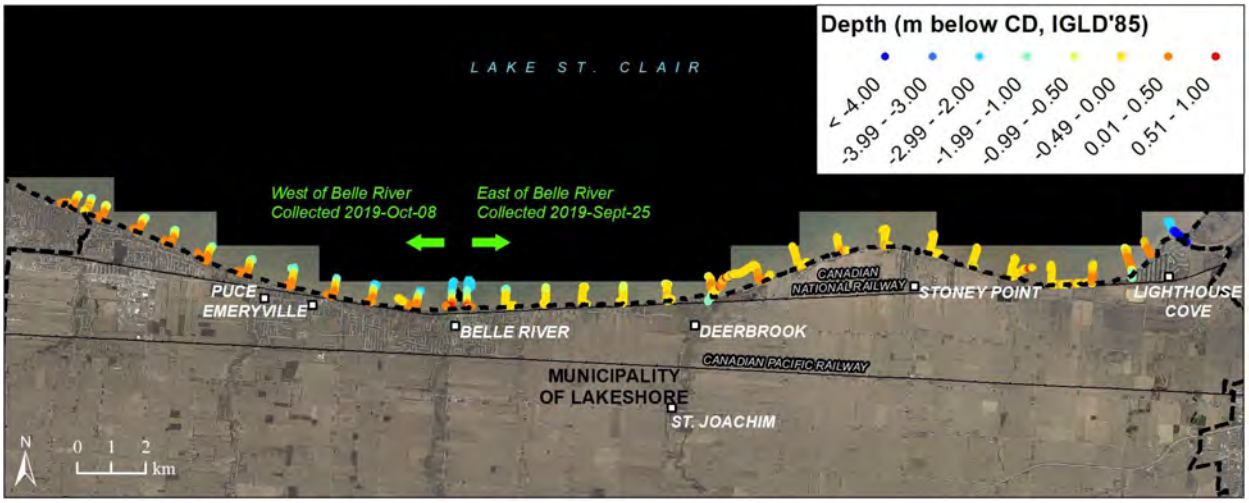
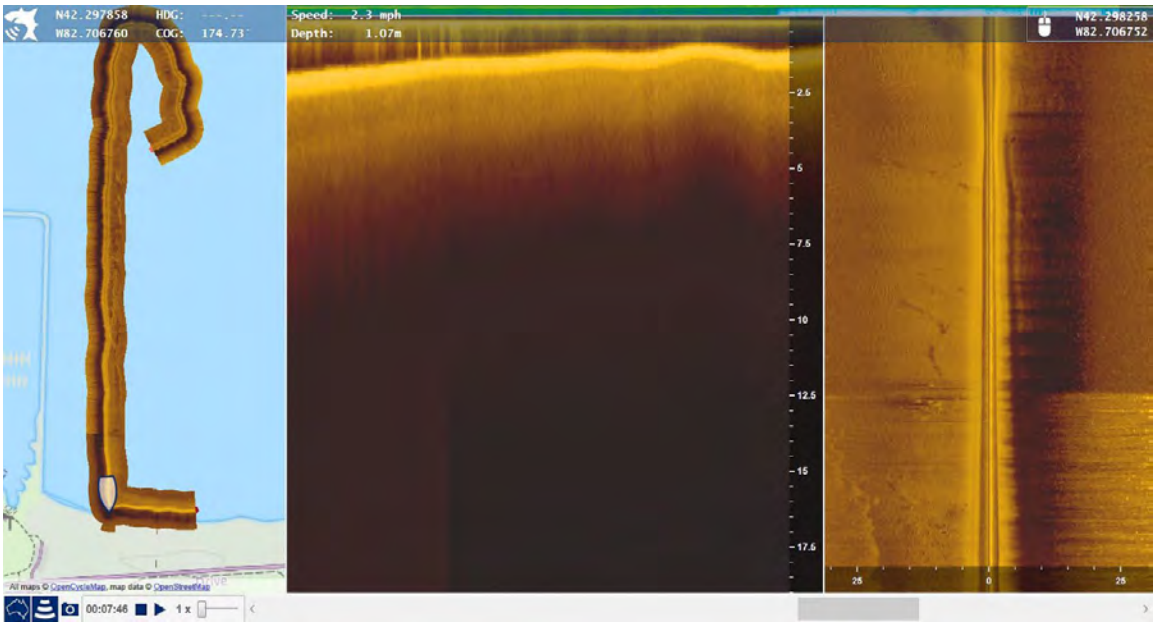


Figure 3.3 Extent of Data Collection with the SOLIX (Sept. 25 and Oct. 8, 2019)



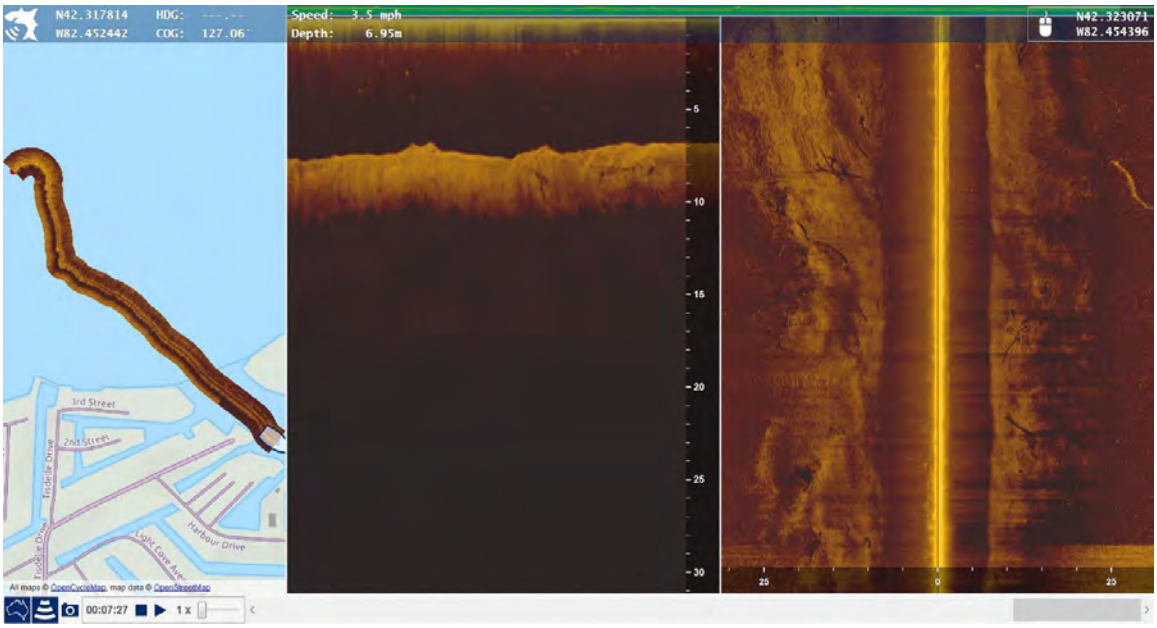
The depth readings were corrected using real-time hydrometric data acquired from the Government of Canada water level website. This real-time data features water level readings taken at hourly intervals. The SOLIX also collects 2D sonar imaging in cross-section and bottom image formats. Figure 3.4 provides an example of the output at the Belle River Marina. The panel on the left displays the track of the boat (the boat symbol depicts the location of the SOLIX relative to the track). The middle panel provides a cross-sectional view of the sonar output, which is recording the sandy lake bottom conditions adjacent to the marina. The image on the right shows the downward looking sonar output (the lake bottom).

Figure 3.4 Bottom Imaging at Belle River Marina



A sample of the bottom imaging collected with the SOLIX at the mouth of the Thames River is provided in Figure 3.5. The boat is traveling onshore, as seen in the left panel. The middle pane provides a cross-sectional image of the lake bottom, which features an irregular bottom and possibly exposures of glacial till. The image on the right shows the glacial sediment ridges and tree limbs that have accumulated on the lake bottom.

Figure 3.5 Bottom Imaging at Thames River Mouth



3.1.3 Update Buildings Layer

The Municipality of Lakeshore provided an existing buildings layer to be used in the study. It was acknowledged that this dataset was older and does not include some recent buildings and housing developments. The main purpose of this layer was for use in 3D renderings of flooding hazards.

The buildings layer was reviewed for the areas included in the 3D renderings discussed in Section 4.4. The following changes were made by Zuzek Inc. for the buildings within proximity of the flood hazard setbacks:

- Missing buildings were added when visible in the 2020 orthophoto.
- Buildings were removed that where not seen in the 2020 orthophoto.
- Some building classes (e.g., Residential, Industrial) were revised to reflect the 2020 orthophoto conditions.
- The shape of some building footprints was reshaped and modified to better align with buildings seen in the 2020 orthophoto.
- A field named *source* was added to the layer's attribute table. All new buildings were attributed as 'Zuzek Inc' in the *source* field.
- A field named *AerialDate* was added to the layer's attribute table. All new buildings were attributed as '2020' in the *AerialDate* field since they were derived from the 2020 orthophoto.

An example of the revised buildings layer is illustrated in Figure 3.6. The noted changes to the attribute table will allow the Municipality of Lakeshore to update the buildings layer for the entire municipality if desired.

Figure 3.6 Revised Buildings Layer at Belle River (new buildings added are colour shaded)

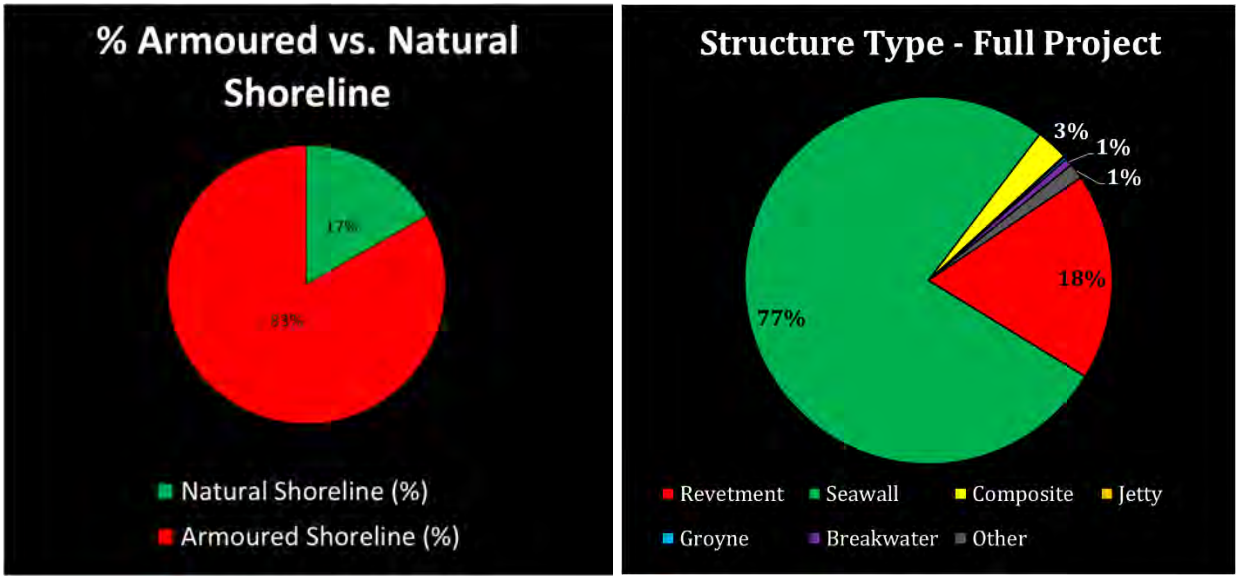
3.2 Technical

The technical analysis completed for the shoreline management plan is described in the following report sections.

3.2.1 Shoreline Protection Database

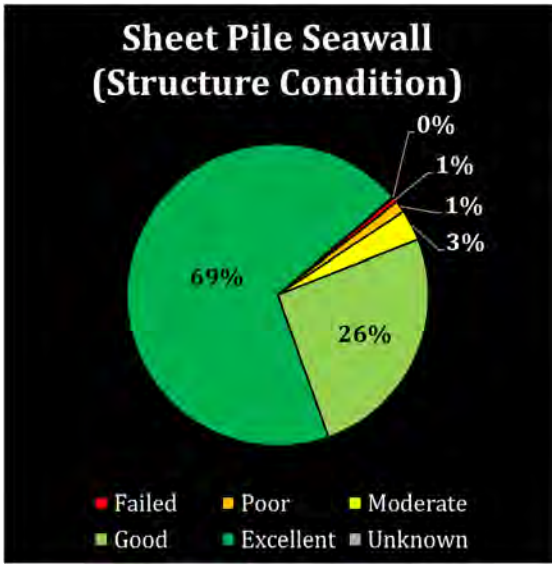
A detailed shoreline protection database was developed as a component of the study to document the state of the built-up shoreline as of September/October 2019. The database was developed primarily from the oblique aerial photography inventory discussed in Section 3.1.1 and supplemented with ground observations. We learned 83% of the shoreline is armoured and seawalls make up 77% of the structure types, as seen in Figure 3.7.

Figure 3.7 Sample of Shore Protection Database Statistics



The information on the overall condition of the different structure types also provided valuable data for the study. For example, as seen in Figure 3.8, 95% of the structures are in good to excellent condition from a structural perspective. However, we subsequently learned during the flooding assessment that the crest elevation of many of the seawalls are too low and don't provide adequate protection from wave overtopping, leading to the propagation of floodwaters inland. In some cases, these structures were not designed to limit overtopping but rather protect lots from shoreline erosion. Other measures, such as raising first floor elevations, were implemented to protect buildings from flooding.

Figure 3.8 Condition Assessment of Steel Sheet Pile Seawalls



3.2.2 Historical Shoreline Change Rates

The previous Essex County Shoreline Report completed by Dillon (1976) included shoreline erosion inventory maps for sections of the Municipality of Lakeshore shoreline. An example is provided in Figure 3.9.

Figure 3.9 Shoreline Erosion Inventory Maps (Dillon, 1976)

The long-term erosion rates for the unprotected shorelines derived from these maps are still used by ERCA and can be summarized as follows:

- West of Belle River erosion rate = 0.3 m/yr.

- Belle River to a location just west of Comber Sideroad erosion rate = 0.4 m/yr.
- West of Comber Sideroad and to Thames River Mouth erosion rate = 0.5 m/yr.

The County of Essex provided aerial photos covering 1975 to 2020 (Table 3.1). Note that the 2020 photo was provided after the study commenced and the shoreline change analysis was already complete.

Table 3.1 Summary of Aerial Photos Provided

YEAR	FORMAT	SCALE	NOTE
1975	Scanned aerial print	5,000	8 tiles were registered by Zuzek Inc.
1988	Scanned aerial print	8,000	1 tile was registered by Zuzek Inc.
2004	Orthophoto mosaic	N/A	10 cm resolution
2019	Orthophoto mosaic	N/A	10 cm resolution
2020	Orthophoto mosaic	N/A	10 cm resolution

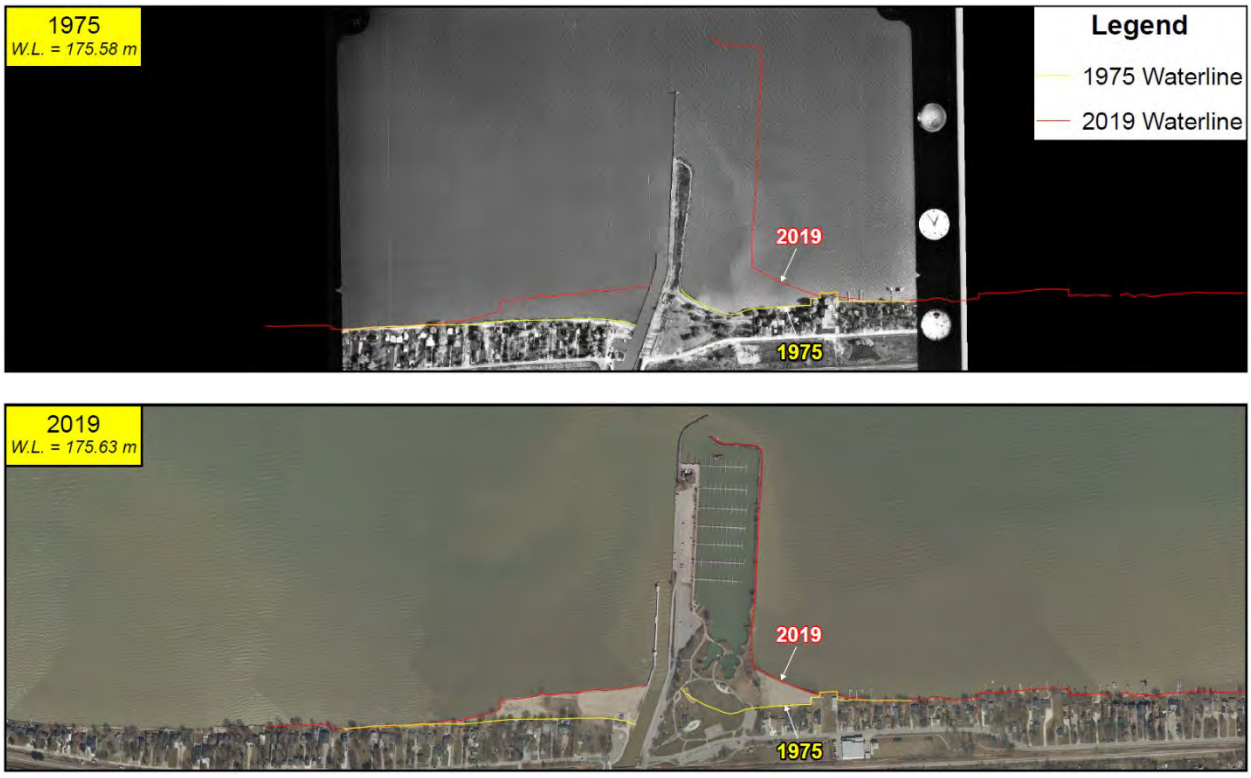
To visualize the shoreline change, a shoreline (waterline) was digitized from the 1975 and 2019 aerials. The monthly mean water levels on Lake St. Clair at the time of these aerial photos is as follows:

- 1975 monthly mean = 175.58 m IGLD'85
- 2019 monthly mean = 175.63 m IGLD'85

The difference between the two water levels is only 5 cm. Therefore, a water level correction of the digitized shorelines was not performed, as the correction amount would be indistinguishable from the non-corrected linework. For example, a beach slope of 1:10 would result in only a 0.5 m horizontal line correction.

The waterlines were then overlayed on the aerials. For the properties with shore protection, the difference in waterlines is minimal. Figure 3.10 presents a comparison of the 1975 and 2019 waterlines on the 1975 and 2019 aerial photos at Belle River. There has been significant growth in the east and west fillet beaches at Belle River since 1975, as seen in the comparisons.

Figure 3.10 Waterline Comparison at Belle River



Additional shoreline change comparisons are presented in Appendix D.

3.2.3 Water Level Analysis

Shoreline hazards are defined using the 100-year lake level. This flood level is derived from a combination of static water levels and storm surge having a joint probability of occurrence of 1% in any given year. The lake level presently used in the regulation of the Lakeshore shoreline is derived from previous work by the MNRF (Great Lakes System Flood Levels and Hazards, 1989) and Dillon Consulting (Essex County Shoreline Report, 1976). These reports estimated the 100-year lake level at Belle River to be 176.33 m and 176.36 m IGLD85', respectively, based on a combination of statistical analyses of historical water level data and theoretical computations. The current regulatory lake level used by the Essex Region Conservation Authority vary spatially along the shoreline and are summarized in Table 3.2.

Table 3.2 Existing 100-year Lake Level from ERCA

Reach	Thames River to Stoney Point	Stoney Point to Belle River	Belle River to Pike Creek
100-year lake level (m, IGLD'85)	176.57	176.33	176.39

Since the previous estimates by Dillon (1976) and MNRF (1989), several decades of higher resolution water level data have been logged at gauges around Lake St. Clair. To provide an up-to-date and more accurate estimate of the combined flood level along the south shore of Lake St. Clair, an updated joint probability analysis of static water levels and storm surge at the Belle River Gauge was performed and is presented in the following sections.

3.2.3.1 Updated Static Lake Levels

Measured historical static water level data is archived by the Department of Fisheries and Oceans (DFO) for various gauging stations across the Great Lakes, including Lake St. Clair. Monthly mean water levels for Lake St. Clair, based on averages from a network of gauging stations, were obtained from these archives for 1918 through 2020 (103 years). The obtained water level data was divided into to 12 monthly datasets, ranked and subjected to several statistical models for extreme value analysis. Normalcy testing was performed using the Chi-Squared test statistic, indicating most months could be described by a normal distribution with a reasonably high level of confidence (α=0.05). The datasets were also fitted to a number of extreme value distributions including: (1) Weibull, (2) Fisher-Tippett, (3) Generalized Extreme Value (GEV) and (4) Generalized Pareto.

The Weibull and GEV distributions generally provided the best fit to the monthly static lake level data (Figure 3.11), with minimum correlation coefficients across all datasets of 0.996. The other extreme value distributions provided considerably lower correlation coefficients and thus were not utilized for further analyses. There was some variation in 100-year static WL estimates between the Weibull and GEV distributions, up to 5 cm depending on the month. To ensure conservatism in the analysis, the higher of the two estimates was generally taken, provided the correlation coefficients were similar.

Figure 3.11 Left: Weibull distribution for June static WL data (Corr. Coeff. = 0.998) Right: GEV (Method of Moments) distribution for April static WL data (Corr. Coeff. = 0.998)

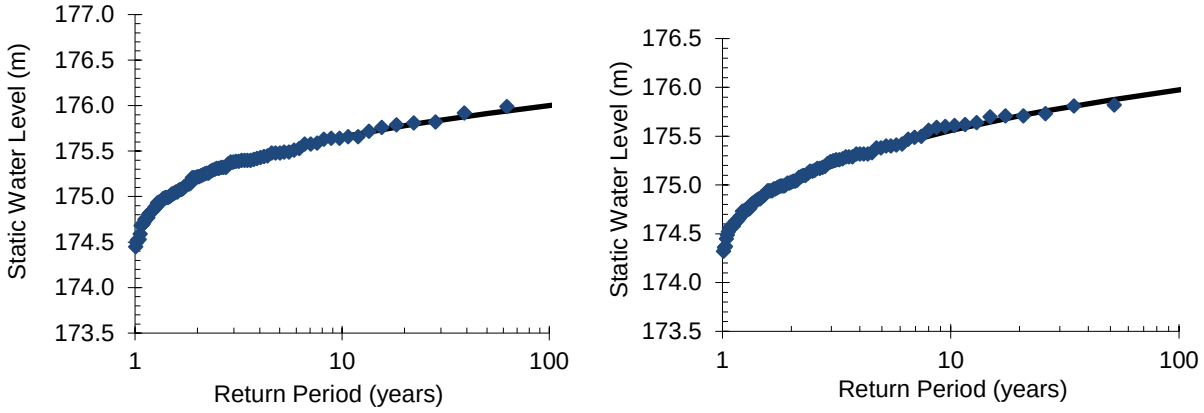


Table 3.3 provides a summary of results from the monthly extreme value analysis of static water levels described above. The governing predicted 100-year static WL is 176.04 m IGLD85', occurring in July. The last published static WL estimate for this area was 175.95 m, based on data recorded between 1900 and 1987 (MNR, 1989). The findings from this analysis exhibit a 9 cm increase over the findings of the MNR – to be expected given the inclusion of the high static lake levels experienced in recent years (e.g., 2019 and 2020).

Table 3.3 Maximum observed and predicted 100-year monthly static lake levels for Lake St. Clair (based on data from 1918-2020)

	Monthly Lake Level in m IGLD85' (1918 - 2020)	
Month	**Max Observed WL**	**Predicted 100-year WL**
January	175.80	175.85
February	175.80	175.86
March	175.83	175.91
April	175.91	175.97
May	175.98	175.97
June	176.02	176.00
July	176.04	176.04
August	175.97	175.97
September	175.88	175.91
October	175.96	175.83
November	175.82	175.78
December	175.80	175.79
Max =	**176.04**	**176.04**

3.2.3.2 Storm Surge

Storm surge occurs when there is a temporary water level rise during a storm, resulting from the combined effects of barometric pressure gradients and wind setup across a

water body. On large inland lakes, wind setup is typically the most substantial contributor to storm surge, as the effects of pressure variations are relatively small. Wind setup occurs when wind-induced shear stress at the water-air interface pushes water in the same direction as the prevailing wind, causing a temporary rise in water levels at the downwind shore. The amplitude of a storm surge event is dependent on the local wind speed, wind direction, fetch (lake distance over which the wind is blowing), shoreline orientation, and lakebed bathymetry.

Storm surge events can be interpreted from measured water level data as long as the temporal resolution is sufficiently high to capture surge events, which typically last several hours. The Belle River water level gauge (Station ID: 11965) on Lake St. Clair is within the study area and has sufficient data resolution for a storm surge analysis. Data from the Belle River Station was sourced from the Department of Fisheries and Oceans (DFO) for the period of 1961 to 2020 (60 years). Archived data was available in varying resolution, with hourly data available between 1961 and 1988, 15-minute data available between 1989 and 2002, and 3-minute data available post-2002. Storm surge analysis was completed using hourly data; however, selected surge events were compared to higher resolution data to ensure maximum surge levels had been captured by the hourly data.

To isolate and quantify surge events from the water level dataset, each individual data entry was compared to background static lake levels to highlight temporary positive residuals at the gauge location (surge events). To determine the background static lake level, a 72-hour average was calculated for every data point, excluding the central 24 hours (12 hours before and after the point of interest). The 72-hour average lake levels were then subtracted from instantaneous water levels, with resultant high-magnitude, positive residuals representing potential surge events. The data was then separated into 12 monthly datasets, each including data from the month preceding and following (i.e., the January data set included December, January, and February events) in order to remove any bias associated with surge events occurring at the boundaries between months. This adds an additional layer of conservatism to the surge analysis. The Peak Over Threshold (POT) method was then applied to obtain the n-largest independent surge events from each monthly dataset such that the number of events was equivalent to the number of years of data (n=60 for this analysis). A minimum duration of 36-hours between events was applied to ensure independence of the selected storm events.

Surge datasets were fitted to various cumulative probability distributions for extreme value analysis. Normalcy testing (Chi-squared) indicated that the data could not be described using a normal distribution. The extreme value distributions described above were therefore applied. The Weibull and GEV distributions generally provided consistently good fits for the surge data, with higher correlation coefficients for winter months (minimum correlation coefficient from Dec-Mar was 0.99) and lower correlation coefficients for summer months (minimum correlation coefficient from Apr-Nov was

0.94). The Pareto and Fisher-Tippett II (Frechet) distributions also provided an excellent fit for some months, with similar seasonal fit-disparity. This disparity is particularly severe in the September dataset where the highest ranked events were all of similar magnitude and the tail-end data exhibited a plateau as a result (Figure 3.12). This is potentially a result of physical limitations of Lake St. Clair combined with seasonal wind variation. The best fitting distributions were selected for each month, with the predicted seasonal 100-year surge estimates presented in Table 3.4.

Figure 3.12 Left: Pareto (Method of Moments) distribution for September surge events (Corr. Coeff. = 0.974) Right: Weibull distribution for December surge events (Corr. Coeff. = 0.994)

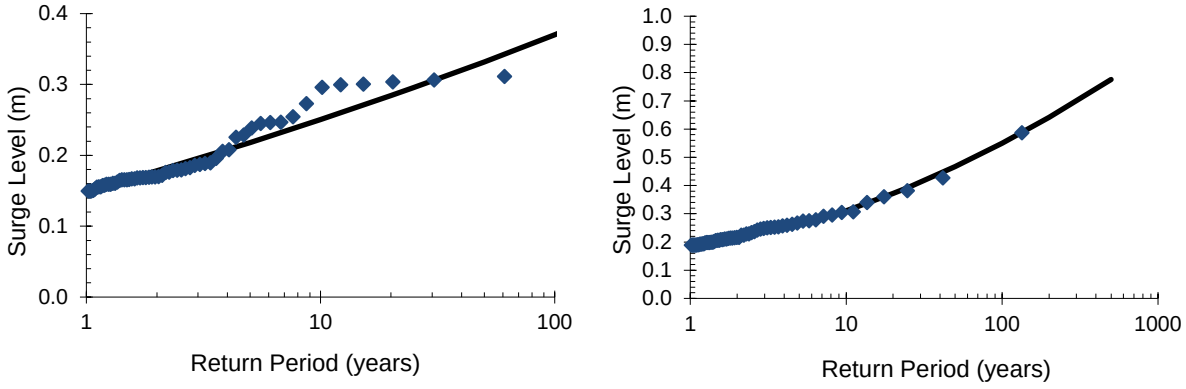


Table 3.4 Seasonal, predicted 100-year storm surge magnitude at the Belle River water level gauge

	Belle River Surge (1961 - 2020)	
Month	**Max. Observed Surge (m)**	**Predicted 100-year Surge (m)**
January	0.43	0.53
February	0.54	0.53
March	0.36	0.52
April	0.40	0.43
May	0.26	0.42
June	0.36	0.32
July	0.26	0.34
August	0.24	0.33
September	0.31	0.37
October	0.31	0.48
November	0.59	0.51
December	0.38	0.55
Maximum =	0.58	**0.55**

Based on the analysis described above, the governing 100-year surge is 0.55 m, occurring in the winter months. This estimate is considerably lower than the previous

estimate of 0.81 m published by the MNRF (1989), which was based on historical data recorded between 1957 and 1986. It is likely that the 1989 estimate provided by the MNRF extrapolated too far beyond the limited 30-year dataset. The new estimate, although lower, is expected to be more accurate with 60+ years of contributing data and improved extreme value analysis techniques.

3.2.3.3 Joint Probability (Static WL + Surge)

A joint probability analysis (JPA) was completed for each of the 12 monthly static water level and storm surge datasets, to determine combined lake levels for each month of the year. Monthly (seasonal) static water level and storm surge distributions used in the JPA were based on visual fitting and achieved correlation coefficients (as discussed in the sections above).

In the joint probability analysis, static lake level and storm surge are treated as independent variables X and Y, respectively. Once extreme value distribution is fit to each dataset, as discussed above, multi-variate discretization is performed, and the convolution formula is used to assess the joint probability of combined water levels, Z (where Z = X + Y). The resulting joint probability equation can be expressed as:

$$P(Z) = \sum_{Rx} P(X) \cdot P(Z - X)$$

Figure 3.13 presents a sample cumulative distribution plot resulting from the joint probability analysis of combined water levels, for the month of June at the Belle River gauge. The combined flood level, Z (static water level + storm surge), can be obtained from the figure for any return period based on the respective cumulative probability. For example, a return period of 100 years indicates a cumulative probability of 0.99 for any given year (1-1/100). The corresponding z-value (combined water level) can be read from the X-axis and is +176.21 m IGLD85' for the month of June.

Figure 3.13 Cumulative joint probability distribution plot of combined lake levels (static water level + storm surge) at Belle River for the month of June

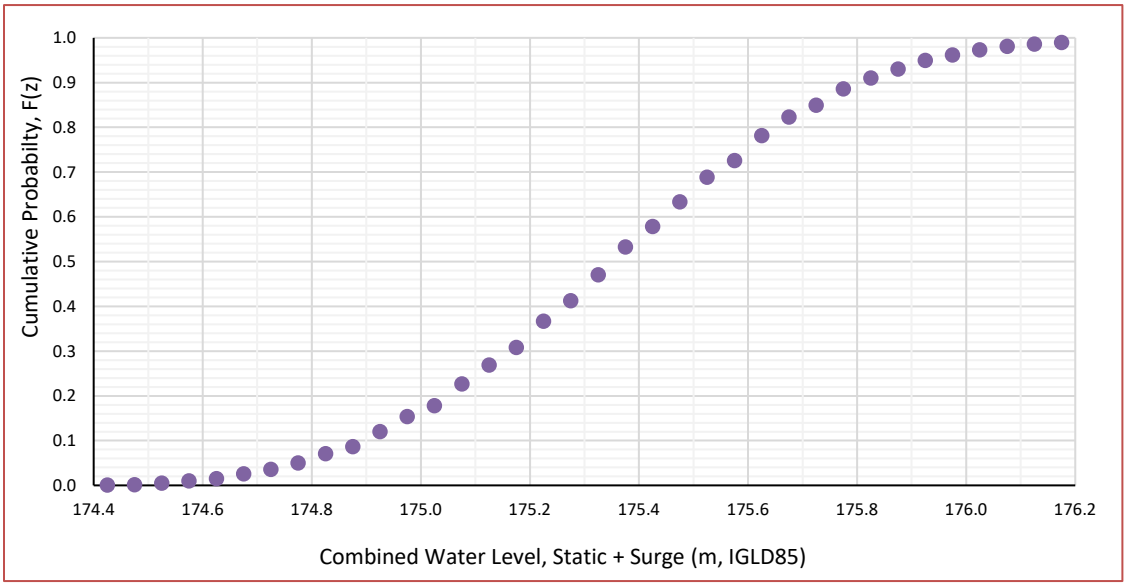


Table 3.5 provides summary results for the joint probability analysis of combined lake levels (static WL and storm surge) for all months at the Belle River gauge.

Table 3.5 Summary of predicted combined lake levels at Belle River based on the joint probability analysis of static water level and storm surge

	100-year Combined Flood Level (m IGLD85')
Month	**Belle River**
January	176.10
February	176.11
March	176.19
April	176.24
May	176.22
June	176.21
July	176.23
August	176.18
September	176.13
October	176.11
November	176.07
December	176.08
Maximum =	**176.24**

Based on the results of the joint probability analysis, the governing 100-year combined flood level at Belle River is estimated to be +176.24 m IGLD85'. This value was predicted for the month of April; however, the months of April, May, June and July are very similar, suggesting the 100-year combined flood level could be realized during any of these months. The estimated 100-year level is 12 cm and 9 cm lower than values

previously published by the MNRF in 1989 (+176.36 m IGLD85') and Dillon in 1976 (+176.33 m IGLD85'), respectively. The slightly lower values are primarily due to the difference in extreme surge estimates. More confidence can be placed in the surge estimate presented herein, as the analysis is backed by 60+ years of historical data and improved surge estimation and extreme value analysis techniques. For reference, the highest recorded hourly water level throughout the entire 60+ year operation of the Belle River water level gauge is +176.19 m IGLD85'.

Despite the confidence in the presented results, it is not recommended that the current regulatory flood levels be reduced to the 100-year estimate derived from this analysis, particularly due to the increased frequency of high lake levels across Lake St. Clair in recent years and future projections for climate change impacts. Therefore, 100-year lake levels summarized in Table 3.2 will be used to map the flood hazards in Lakeshore.

3.2.4 Nearshore Waves and Runup

Wave action has the potential to contribute to shoreline flooding hazards beyond the limits delineated by the 100-year combined flood level. Wave action contributes to shoreline hazards primarily through two mechanisms: wave runup (or wave uprush) and wave overtopping of structures. Wave runup is defined as the vertical height above the still water level that a wave will reach as it rushes up a natural shoreline or structure. Wave overtopping occurs when wave action exceeds the vertical limits of shoreline banks or structures, causing a flow of water to backshore areas. This flow of water, although occurring intermittently in reality, is often quantified as a mean discharge measured in litres/second per metre of shoreline.

To provide an estimate of wave action contributions to flooding hazards along the Lake St. Clair shoreline, an analysis of shallow water wave conditions (near the shoreline) was performed, including predicting offshore wave conditions from historical wind data, predicting changes to the wave conditions as they move into shallow water, and reach the shoreline leading to wave overtopping and runup on the shoreline. Methodologies and results from these analyses are presented in the following sections.

3.2.4.1 Nearshore Wave Climate

Wave growth is related to the magnitude, direction, and duration of winds blowing over a waterbody. It is possible to hindcast historical wave conditions using available wind data. Using parametric hindcasting techniques, various return period wind events can be translated to the respective return period (RP) wave height and wave period. Parametric hindcasting was used to establish wave conditions on Lake St. Clair correlating to the 1-year event up to the 500-year event for the region based on the following methodology.

3.2.4.2 Extreme Value Analysis – Wind Events

Hourly wind data was obtained from the Government of Canada's historical climate station database. The station closest to Belle River Marina with adequate data (minimum 30 years) was Windsor Airport. Monthly datasets of hourly wind data (wind speed and direction) were obtained for the period between January 1953 and September 2014 (62 years). Wind speeds in this dataset were measured 10 m above the ground for a 1-, 2- or 10-minute period ending at the time of observation. The hourly wind speed was recorded as the average over the measured interval.

Due to the geometry and spatial orientation of Lake St. Clair, northerly winds (blowing from the north) will generate the largest waves on the south shore of Lake St. Clair. Consequently, an extreme value analysis was performed for northerly wind events only. Northerly winds were identified as any wind direction ranging from northwest to northeast, or between 270 and 90 degrees. Northerly wind events were ranked by wind speed, and the top 62 events were selected for the extreme value analysis such that the number of events was equivalent to the number of years of data (n = 62). For selection of the top-ranked events, a minimum duration of 36 hours between events was applied to ensure independence. Wind speeds also had to exceed 35 km/hr for at least 4 consecutive hours to qualify as a significant wind event.

The ranked dataset of wind events was fitted to various cumulative probability distributions for extreme value analysis. Normality testing (Chi-squared) indicated that the data could not be described using a normal distribution. The Fisher Tippett II (Frechet) and Generalized Extreme Value (fitting via Method of L-moments, MLM) distributions generally provided the best fit, with a minimum correlation coefficient of 0.992 (Figure 3.14). Table 3.6 provides a summary of results from the wind EVA, including an average from the two distributions that exhibited the best fit.

Figure 3.14 Historical wind data modeled with A) the Fisher Tippett II (Frechet) distribution and B) the Generalized Extreme Value distribution (MLM fitting)

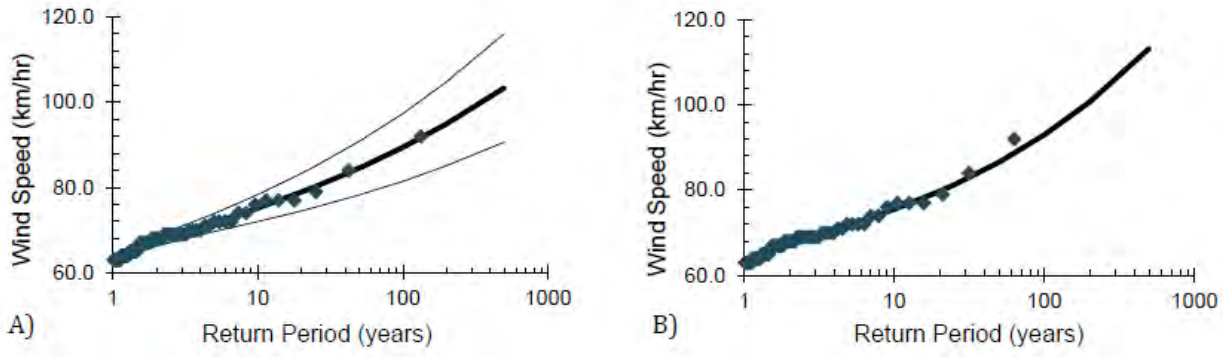


Table 3.6 Summary of EVA Results for Sustained Wind Speeds (NW to NE directionality) – Windsor Airport

	Peak Sustained Wind Speeds (km/hr)		
RP (years)	1. FT II (Frechet)	2. GEV MLM	Average (1/2)
1.5	65.92	66.23	66.07
2	67.44	67.62	67.53
5	71.78	71.86	71.82
10	75.18	75.48	75.33
20	78.91	79.71	79.31
25	80.20	81.23	80.72
50	84.53	86.56	85.54
100	89.41	92.95	91.18
200	94.92	100.64	97.78
500	103.35	113.26	108.30
Corr. Coeff.	0.9936	0.9915	

3.2.4.3 Wave Hindcasting

The extreme value analysis results presented in Table 3.6 (column three) were used for parametric wave hindcasting (predicting wave heights based on wind speed). Methods from the US Army Corps of Engineers' Shore Protection Manual (1977) were applied. Inputs included fetch length (open water distance on the lake), storm duration and average water depth over the area of wave generation. The fetch length was taken to be the entire length of Lake St. Clair across its north-south axis: 43 km. A storm duration of 12 hours was assumed for all hindcasted events, and a conservative lake depth of 6 m was assumed based on lake depths obtained from NOAA. Wave height and wave period estimates were developed for deep and shallow water conditions. Due to the shallow nature of Lake St. Clair, wave generation will be depth limited. Consequently, shallow water outputs from the analysis were used for the remainder of wave analyses (Table 3.7).

Table 3.7 Summary of results from parametric wave hindcasting – Lake St. Clair

RP (years)	Wind Speed (km/hr)	1977 SPM – Shallow Water	
		Wave Height (m)	Wave Period (s)
1.5	66.07	1.30	4.7
2	67.53	1.32	4.7
5	71.82	1.37	4.8
10	75.33	1.42	4.9
20	79.31	1.46	5.0
25	80.72	1.48	5.0
50	85.54	1.53	5.2
100	91.18	1.59	5.3
200	97.78	1.65	5.4
500	108.30	1.75	5.7

The results from wave hindcasting were validated against wave data archived by the Department of Fisheries and Oceans (DFO) for Lake St. Clair (buoy C45147). Wave data for Lake St. Clair was available between 2000 and 2019. The limited dataset provided minimal comparison for extreme wind events, however, the magnitude and relative frequency of wave events recorded at the Lake St. Clair buoy throughout the 20-year period were in general agreement with the predicted wave heights.

3.2.4.4 Nearshore Wave Transformations

The wave characteristics determined from parametric hindcasting are representative of offshore wave conditions. Nearshore wave transformations such as wave shoaling and wave breaking must be taken into consideration to determine wave conditions along the shoreline. Shuto's Non-Linear Shoaling (1974) and Goda's formulation for wave breaking (1985) were applied to transform the offshore waves to depth-limited nearshore waves for decreasing water depths.

To accurately estimate nearshore lakebed slopes for the project shoreline, bathymetric data for Lake St. Clair, collected in Fall 2019, was consulted. The bathymetric profiles (31 in total) were grouped into four representative beach profiles, shown in Figure 3.15. Each of the four profiles were utilized in nearshore wave transformation calculations to determine the relationship between water depth and significant wave height. Water depths were based on a 100-year lake level of +176.4 m G.S.C. Differences in significant breaking wave height between the four profiles were minimal, thus an average from all profiles was determined for use in overtopping and runup analysis. The 100-year outputs from nearshore wave transformation were used in overtopping and runup analysis and are presented in Table 3.8.

Figure 3.15 Representative shoreline profiles for Lake St. Clair within the project area

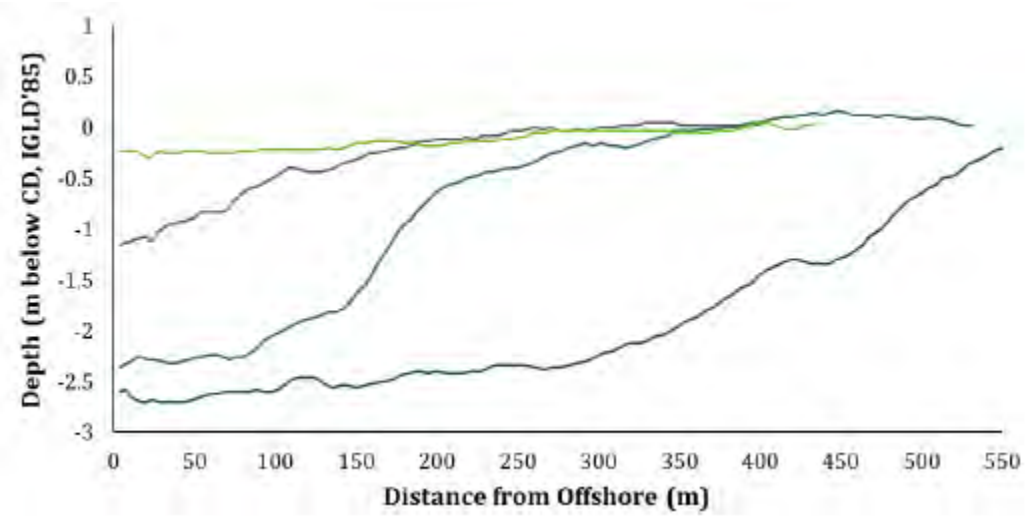


Table 3.8 Results from nearshore wave transformations for 100-year wave conditions

Water Depth (m)	Significant Wave Height, H_b (m)	Maximum Wave Height, H_{max} (m)	Deepwater Wave Height, H_o (m)	Wave Period, T_p (seconds)	Wave Length, L (m)
2.2	1.33	1.72	1.74	5.3	23.71
2.0	1.23	1.59	1.74	5.3	22.72
1.8	1.11	1.45	1.74	5.3	21.65
1.6	1.00	1.32	1.74	5.3	20.50
1.4	0.90	1.19	1.74	5.3	19.26
1.2	0.79	1.08	1.74	5.3	17.90
1.0	0.69	0.95	1.74	5.3	16.40

3.2.4.5 Wave Overtopping and Beach Runup

Flood contributions from wave overtopping and runup were considered for a range of beach slopes and shoreline structures. Toe and crest elevations were selected to cover the range of conditions present on the Lake St. Clair project shoreline. This range was determined from the lake depths and shoreline topographic surveys. Based on these ranges, three toe (base of wall) and three crest elevations (top of wall) were selected and tested in combination to establish matrices of overtopping scenarios for both vertical and sloping structures. The toe and crest elevations used in the analysis, along with the overtopping analysis results, are provided in Table 3.9. Overtopping results were based on an average of two methods: EuroTop (2016) and Goda (2010).

Table 3.9 Summary of results from overtopping analysis

VERTICAL STRUCTURE - Overtopping (l/s*m)				
Elevation (m IGLD85')		Toe		
		174.2	174.6	175
Crest	176.5	1204	1042	884
	177.0	215	137	76
	177.5	45	22	9
SLOPING STRUCTURE - Overtopping (l/s*m)				
Elevation (m IGLD85')		Toe		
		174.2	174.6	175
Crest	176.5	192	143	101
	177.0	83	51	27
	177.5	31	15	6

An analysis of beach runup during the 100-year wave event was performed for the pockets of sandy beach shoreline in the project study area. Beach slopes were observed to range from 1:10 to 1:20. The steeper slopes are found on long straight sections of shoreline, while the more gradual slopes occur in fillet beaches on either side of shore perpendicular infrastructure (e.g., jetties). Wave runup was calculated for both slopes, assuming a smooth sandy beach (reduction factor = 1). Various methods were used for these calculations (Hunt, 1959; MNR, 2001; Holman, 1986; Modified Mase, 1989) and an average for both beach slopes is presented in Table 3.10. Runup values were added to the 100-year lake level (e.g., 176.4 m IGLD85' for Belle River to Pike Creek) to establish the regulatory flood hazard limit (100-year water level plus an allowance for wave uprush), which are also provided in Table 3.10 for the two beach slopes. These data were used to map the Flood Hazard Limit discussed in Section 4.0.

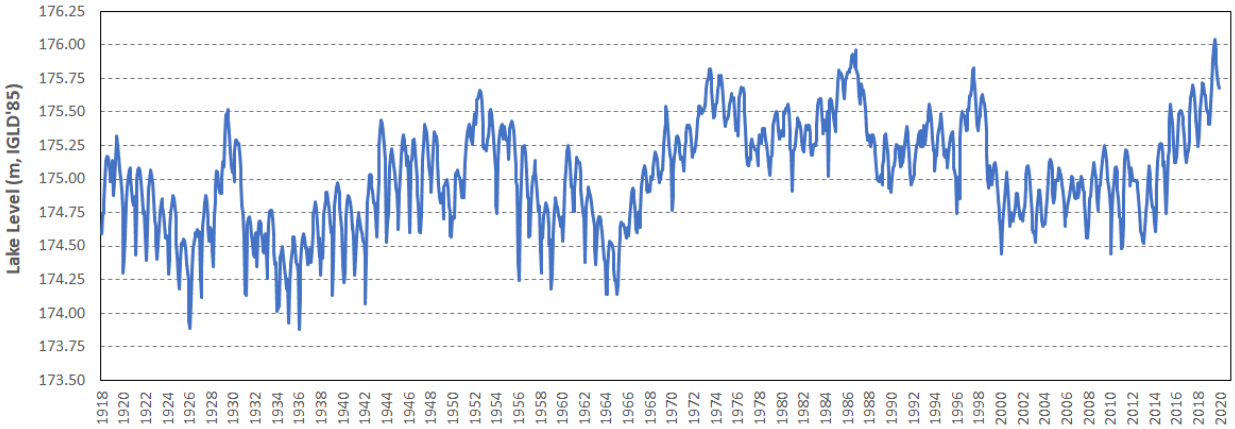
Table 3.10 Summary of results from beach runup analysis for Reach 1

Slope	R2% (m)	Flood Elevation (m IGLD85')
1:10	1.21	+177.61
1:20	0.67	+177.07

3.2.5 Climate Change Impacts

The monthly mean water levels on Lake St. Clair from 1918 to 2019 are plotted in Figure 3.16. The lake has fluctuated between periods of highs and lows based on the amount of precipitation delivered to the Great Lakes watershed and losses due to evaporation, evapotranspiration, and outflow via the Detroit River. In 2019, Lake St. Clair established a new record monthly mean water level.

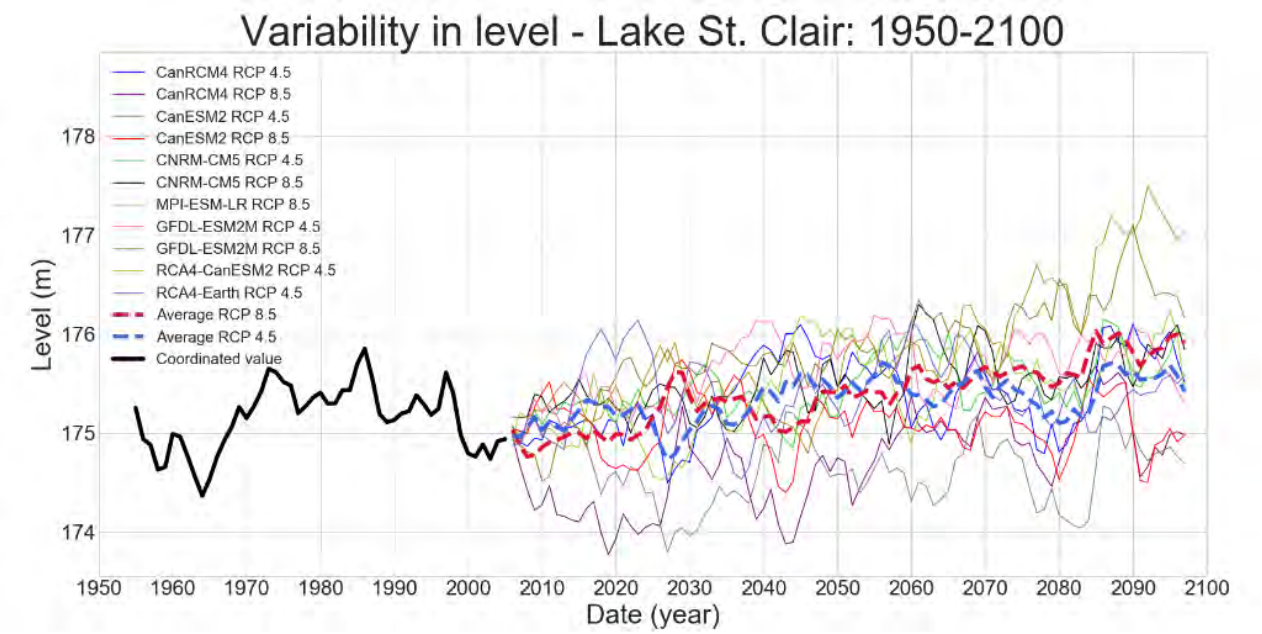
Figure 3.16 Monthly Mean Water Levels on Lake St. Clair (ECCC)



3.2.5.1 Projected Impacts on Future Lake Levels

In a recent report from Environment and Climate Change Canada (Seglenieks and Temgoua, 2021), projections of future lake levels were summarized for global temperature increases of 1.5 to 3.0 degrees Celsius. Data on precipitation, evaporation, and runoff for the analysis was extracted from 13 pairs of Global and Regional Climate Models from the Coupled Model Intercomparison Project Phase 5 (CMIP5). Based on the modelling results, the historical variability in measured lake levels is projected to continue (i.e., periods of highs and lows). However, due to increases in precipitation with a warming climate, both mean lake levels and extreme highs are projected to increase in the future. Refer to Figure 3.17 from Seglenieks and Temgoua (2021). For some of the modelled scenarios, water levels are 0.5 m to over 1.0 m higher than the measured historical data on Lake St. Clair.

Figure 3.17 Projected Future Lake St. Clair Water Levels for Different Global Warming Trends and GCM-RCM Simulations (from Seglenieks and Temgoua, 2021)



The ECCC results on future lake levels are also summarized as probability of exceedance relative to the historical baseline condition from 1961 to 2000. The results for the 1% (100-year) and 50% exceedance (average lake levels) for increases in global mean temperatures from 1.5 and 3.0 degrees Celsius are summarized in Table 3.11. These data indicate that as temperatures in the Great Lakes Basin continue to increase in the future, average lake levels will increase slowly over time (refer to the 50% exceedance results in Table 3.11).

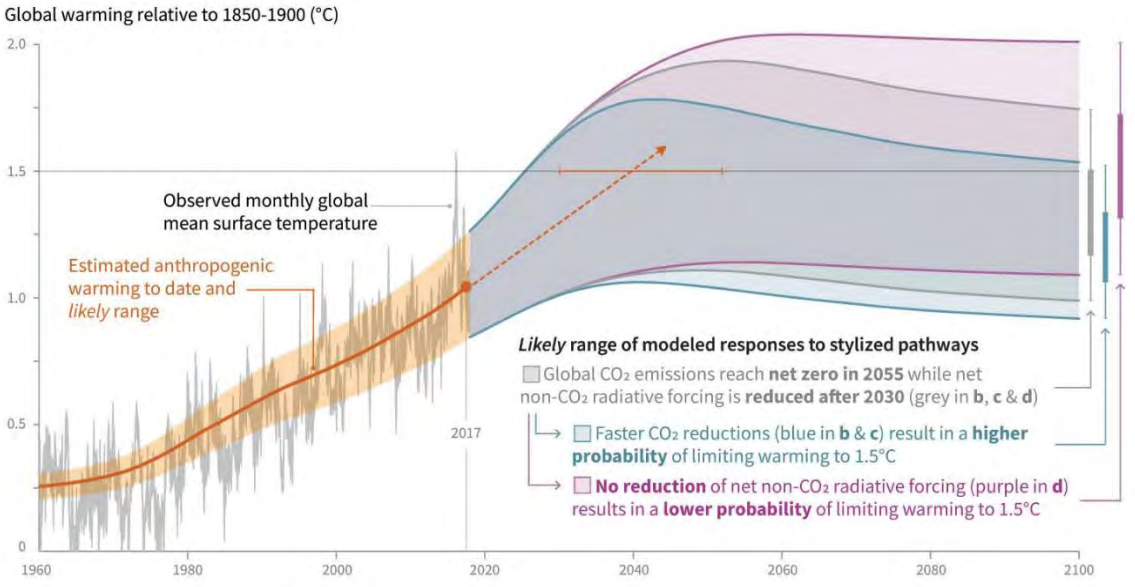
More importantly for the hazard mapping and Shoreline Management Plan, there is an increase in the projected high lake levels for the various warming estimates (refer to 1% exceedance levels in Table 3.11, which is similar statistically to a 100-year static lake level). For other risk assessments in the Great Lakes, Zuzek Inc. is using the average increase in the 1% lake levels for 1.5 and 2.0 degrees Celsius of future warming to integrate climate change impacts. If this approach was applied on Lake St. Clair, the 100-year lake level would be approximately 0.38 m higher than the historical limit based on measured data. When further technical studies and reports are produced in the future, the projected impacts of climate change on the 100-year lake level should be re-evaluated and updated as appropriate in planning and regulatory documents.

Table 3.11 Projected Change in Future Lake Level Extremes (from Seglenieks and Temgoua, 2021)

Percent Exceedance	Projected Increase in Lake Level from Historical Baseline				
	1.5 C of Warming	2.0 C of Warming	2.5 C of Warming	3.0 C of Warming	Average of 1.5 and 2.0 C
1%	0.34 m	0.42 m	0.60 m	1.00 m	0.38 m
50%	-0.02 m	0.09 m	0.14 m	0.23 m	n/a

The 2018 report from the Intergovernmental Panel on Climate Change (IPCC) puts these projected increases in global warming in context by presenting a timeline of historical CO2 emission and future scenarios. There is high confidence that global mean temperatures will surpass 1.5 degrees Celsius between 2030 and 2052 if CO2 emissions continue to increase at the current rate (refer to Figure 3.18).

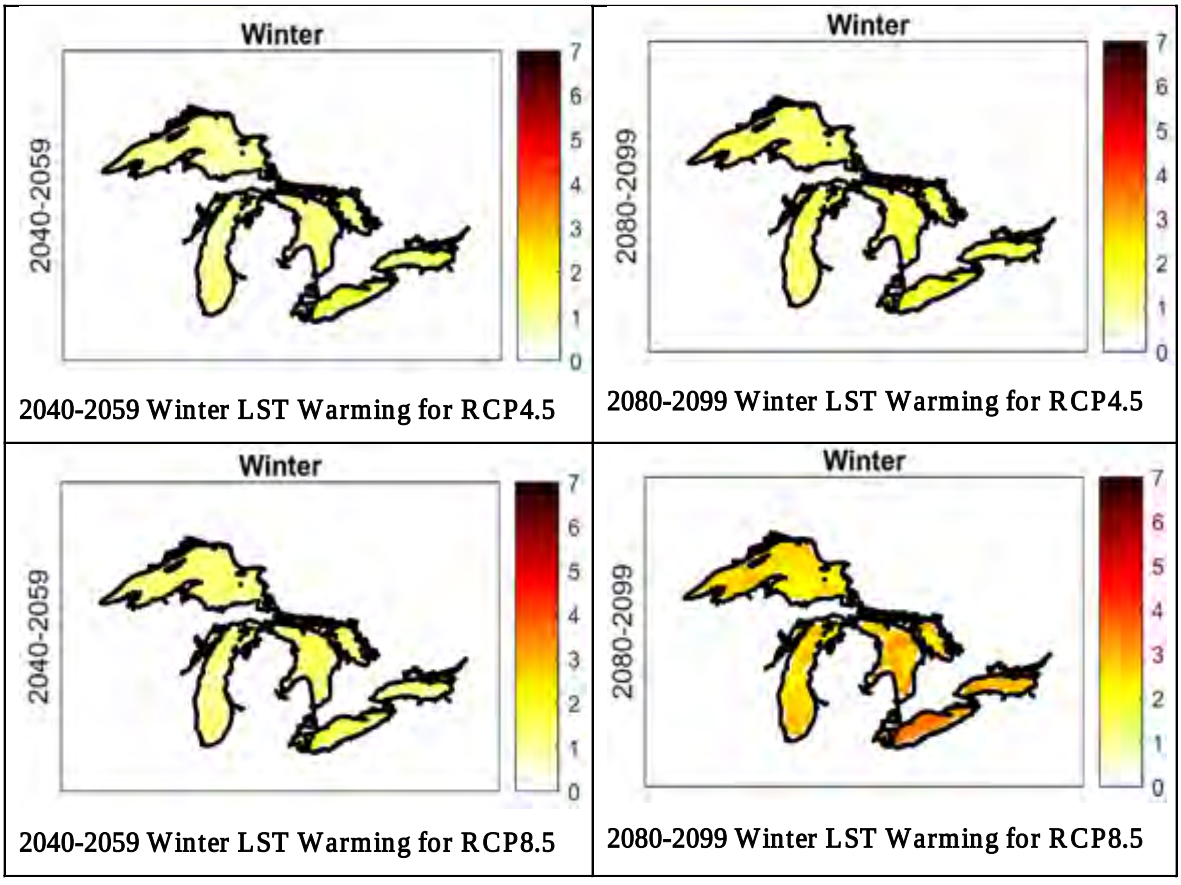
Figure 3.18 Observed Global Temperature Change and Projected Increases for Different CO2 Emission Scenarios (IPCC, 2018)



In Canada's Changing Climate report by Bush and Lemmen (2019), Chapter 4 on temperature and precipitation states that it is virtually certain Canada's climate will continue to warm in the future, with the projected increase in mean temperature in Canada being about twice the global estimate (Zhang, X. et al, 2019). The results presented specifically for Ontario, project an increase in annual mean surface air temperature from 1.5 to 2.3 degrees Celsius by 2030-2050 (Zhang, X. et al, 2019) relative to 1986 to 2005.

Lake surface temperatures have been increasing across the Great Lakes for several decades, including Lake St. Clair (Irambona et al, 2017). Consequently, mean annual ice cover across the Great Lakes has been decreasing since 1975 (Wang et al, 2012). With the projected future warming for Canada's climate (Zhang, X. et al, 2019), these trends will continue. Using 1986 to 2005 as a baseline, projected increases in surface temperature across the Great Lakes for mid-century (2040-2059) and late-century (2080-2099) were recently evaluated with data from the Canadian Regional Climate Model Version 5 (CRCM5) with boundary conditions provided by four Global Climate Models, including CanESM2, NCRM-CM5, MPI-ESM-LR and GFDL-ESM2M (Seglenieks and Temgoua, 2021). The results for the CRCM5/CanESM2 simulation are presented in Figure 3.19. It is difficult to interpret the impacts to Lake St. Clair due to the size of the graphic, but if the southern portion of Lake Huron or the Western Basin of Lake Erie are reviewed, lake surface temperature increases of 0.5 to 3.0 degrees Celsius are projected for the mid- and late century.

Figure 3.19 Mid- and Late-Century Lake Surface Temperature Warming for RCP4.5 (top) and RCP8.5 (bottom) Simulations from CRCM5/CanESM2 Relative to 1986-2005 (Seglenieks and Temgoua, 2021)



This amount of warming resulted in significant loss of ice cover in the future CRCM5 simulations, with estimates for neighbouring Lake Huron and Lake Erie ranging from 30% to 60% for mid-century to 60% to 90% by late-century. These reductions in lake ice cover will expose the Lake St. Clair shoreline to more erosive winter storms and flooding events. Refer to the schematic diagram of reduced winter ice cover on Lake St. Clair in Figure 3.20. While a quantitative estimate of the change in exposure for the shoreline at the St. Clair Unit is not available, a recent analysis on Lake Erie showed that the loss of future ice cover would increase the exposure of the north shore to winter wave energy by 70 to 120% (Zuzek Inc., 2019).

Figure 3.20 Schematic Diagram Showing Potential Loss of Lake Ice Due to Warming on Lake St. Clair

3.3 Analysis of Land Use Approaches to Shoreline Management

The following case studies provide shoreline management approaches and regulatory land use planning tools used for addressing growth along coastlines across Canada. Two specific examples are outlined where conditions are similar to Lakeshore in that much of the shoreline has been developed, and the areas of specific concern are, in large part, low lying.

Village of Port Stanley, Municipality of Central Elgin (Elgin County):

In 2015, the County of Elgin released a Shoreline Management Plan (W. F. Baird & Associates Coastal Engineers Ltd.) that incorporated updated technical mapping for the 100 year flood hazard along the north shore of Lake Erie, as determined by the guidance for determining this natural hazard as outlined by the Province of Ontario and Provincial Policy Statement.

Following that, the June 2021 Port Stanley Harbour Secondary Plan for a specific coastal region of the Municipality of Central Elgin contained a Costal Risk Assessment that updated the development limits and restrictions pertaining to lake levels, flood hazard, erosion hazard and the dynamic beach in a manner that accounted for climate change. The assumed lake level elevation was increased by 0.35m from the 100 year flood hazard identified in 2015 based on update Climate Change Hazard mapping that was developed through the secondary plan process. Any new development that is within the 100 year climate change lake level, as determined through the study, will be required to comply with flood-proofing requirements of the Kettle Creek Conservation Authority (Port Stanley Harbour Plan, Dillion Consulting, June 2021).

Halifax Regional Municipality, Province of Nova Scotia:

In Nova Scotia, the Province has designated land use and zoning powers to the municipality through the Municipal Government Act, much like the Planning Act in Ontario. Halifax Regional Municipality and other municipalities develop planning strategies and bylaw to regulate land uses.

With coastal risk impacting a large area of the Halifax Harbour, the 25-year Regional Municipal Planning Strategy for the Halifax region recognized the importance of climate change and the need for a precautionary approach to minimize negative impacts of rising sea levels. In 2009, report was prepared that outlined three (3) possible future scenarios of flooding that may be experienced by the Halifax harbour and prepared a visual extent and depth of flooding for each event. The first scenario was based on the standard provincial practice for assessment of the flood level, the second scenario mapped the upper limit of the 2007 Intergovernmental Panel on Climate Change (IPCC) projections. The third assessed a flood based on more currently anticipated IPCC levels of concern due to an evolving understanding of climate change (Halifax Harbour Extreme Water Levels in the Context of Climate Change, D. L. Forbes, et al., 2009, Geological Survey of Canada).

The climate risks associated with sea level rise and coastal and overland flooding was integrated with an adaptation strategy for the Halifax waterfront area. Interim measures included an update to the Land Use By-law to ensure the minimum ground floor elevation was increased accordingly. The municipality has recognized that adaptation is an incremental process, using development agreements with all landowners within the impacted areas to ensure development is occurring appropriately with respect to the known and anticipated long-term changes (Planning for Sea Level Rise in Halifax Harbour, Natural Resources Canada, 2015).

In both examples, climate change lake levels were a key consideration incorporated into shoreline management planning and/or flood scenario mapping. In these instances, local municipalities exceeded the expectations of their associated Provincial or regional

governments provided through technical guidance. The examples outlined above were analyzed and used to inform strategic direction of the recommendation of this Report, as contained in Section 5.0.

4.0 Hazard Mapping

The steps followed to map shoreline hazards, including erosion, flooding, and dynamic beaches, are described in the following sections and consistent with the guidance in the Technical Guide (MNR, 2001) and Guidelines for Developing Schedules of Regulated Areas (CO & MNR, 2005). Section 4.2 discusses the maps generated to illustrate these shoreline hazards and visualize the climate change risks.

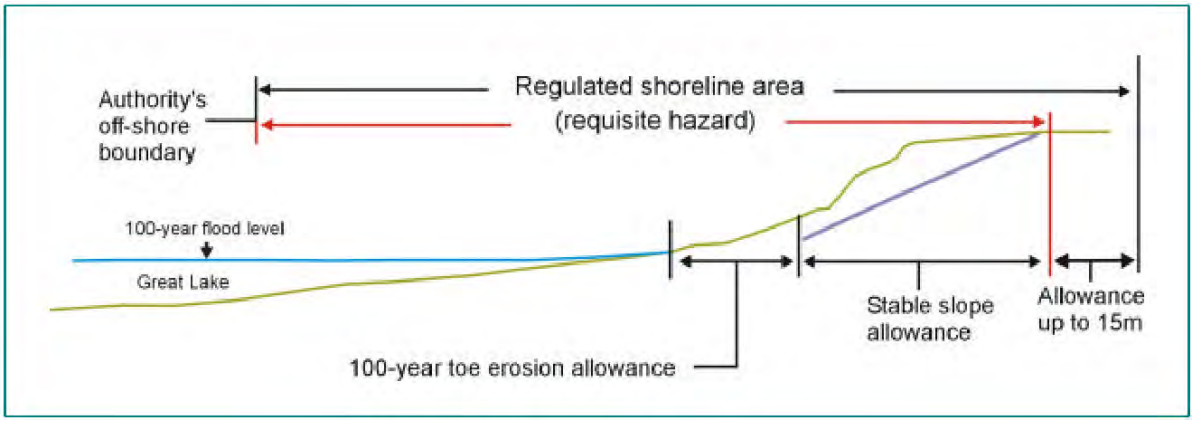
4.1 Hazard Definitions

The hazard definitions and how they are mapped are described below.

4.1.1 Erosion Hazard Limit

The erosion hazard limit setback is defined as a 100-year erosion allowance plus a stable slope allowance measured horizontally from the existing stable toe of slope. When Conservation Authorities identify their regulated area, an additional allowance of up to 15 metres can be added. A schematic of the setback methodology is provided in Figure 4.1. The outputs from this study will only map the 100-year erosion allowance and stable slope.

Figure 4.1 Erosion Hazard Setback Approach



In GIS, a baseline was digitized from the 2019 aerial photo to represent the existing stable toe of slope. Essex Region Conservation Authority (ERCA) provided 100-year erosion rates for three areas within the Municipality of Lakeshore:

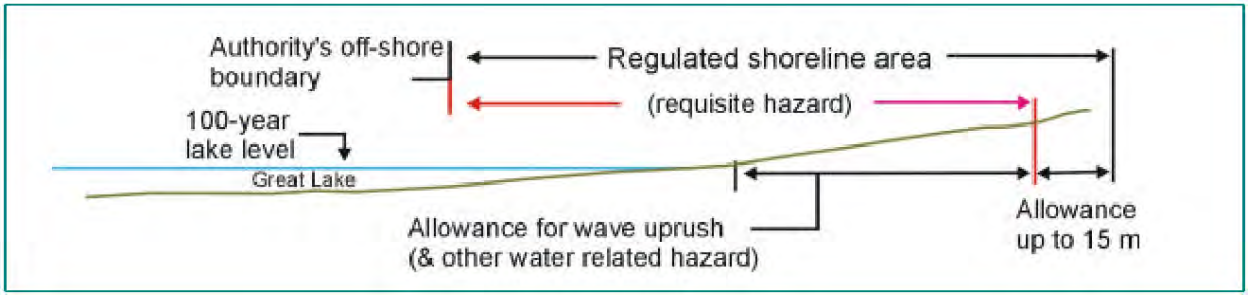
- West of Belle River = 0.3 m/yr.
- East of Belle River to Comber side Rd. = 0.4 m/yr.
- Comber Side Rd. to Municipal limit (Thames Rivermouth) = 0.5 m/yr.

For the area west of Belle River, the 100-year erosion allowance is equal to a 30 m (100 years x 0.3 m/yr) setback from the baseline. For the area east of Belle River to Comber Side Road, the setback was determined to be 40 m (100 x 0.4), while east of Comber Side Road, the setback was 50 m (100 x 0.5). Refer to Section 4.2 for maps illustrating the erosion hazard limit.

4.1.2 Flood Hazard Limit

The flood hazard limit is defined as the 100-year lake level plus an allowance for wave uprush or in the absence of a calculation, 15 m measured inland. When the Conservation Authorities map their regulated area, an optional additional allowance of up to 15 metres also can be added. A schematic of the setback methodology is provided in Figure 4.2. The MNR Technical Guide (2001) provides additional information on the 15 m wave uprush component, including the application of wave runup calculations to define the setback based on site specific nearshore and beach slope, substrate, and local wave conditions. The approach followed for this study was summarized in Section 3.2.4.5 and includes site-specific calculation of beach runup for all exposed sections of shoreline. For wave overtopping situations (e.g., vertical seawalls), the standard 15 m allowance was used.

Figure 4.2 Flood Hazard Setback



The flood hazard limit was mapped in GIS and based on the following methodology:

1. Map the extent of the 100-yr lake level (as a flooded surface). Although information on a 100-year climate change lake level was presented in Section 3.2.5, there is currently no technical guidance in how to integrate this higher elevation from the Province of Ontario. Therefore, the flood hazard limit was mapped with the historical 100-year lake level.

2. Add a 15 m setback from the shoreline for areas with wave overtopping.

3. Add a run-up setback equal to the 100-yr lake level + 70 cm run-up in sandy beach areas. The 100-yr lake level varied by region, as follows:

    - West limit to Belle River = 176.39 m (IGLD'85)

- Belle River to Comber Side Road = 176.33 m (IGLD'85)
- Comber Side Road to East Limit = 176.57 m (IGLD'85)

Note the actual transition at Comber Side Road is approximately 650 m west of Comber Road. Refer to Figure 4.3 for the location of the transition.

Figure 4.3 Transition at Stoney Point

A flood surface was created based on the 100-yr lake level for each of the three locations mentioned above. This surface was merged with 15m buffer of the shoreline, which represented the standard 15 m allowance for wave uprush. Based on the wave run-up analysis, it was determined that adding 70 cm to the 100-yr lake levels would account for wave run-up at properties without shore protection (open coast). The shoreline for unprotected properties (i.e., a natural beach slope) was buffered using the 100-yr lake level + 70 cm. Where the wave run-up was greater than the standard 15 m allowance, the flood hazard surface was edited to include this wave run-up setback. The result was a flood hazard limit polygon capturing the 100-year lake level elevation plus an allowance for wave affects.

Note the following:

- All flooded areas directly connected to Lake St. Clair, or via flooded riverbanks were included in the flood hazard limit polygon dataset.

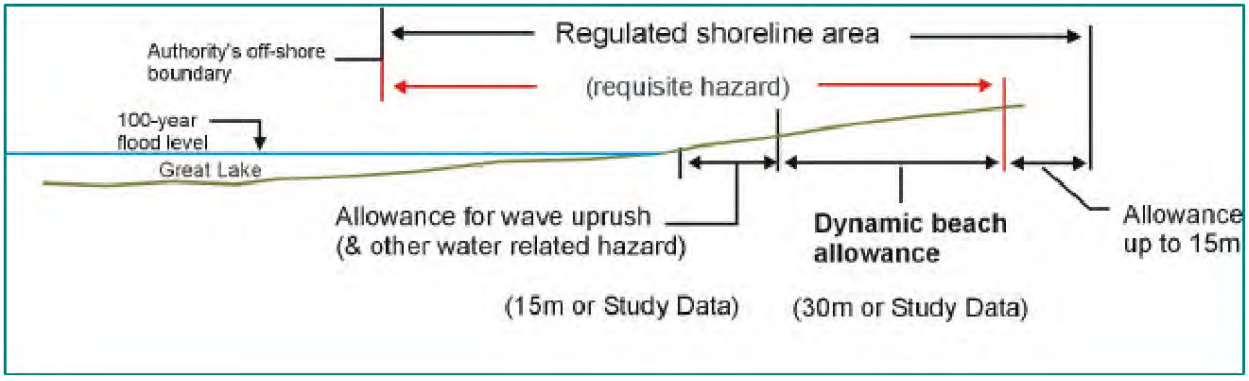
- For lake flooding propagating up the rivers, only the riverbanks directly connected to the lake were included. Identifying localized hydraulic connections to the main rivers, such as drainage ditches, is beyond the resolution of the hazard mapping.
- Inland flooding due to riverbank overtopping was considered using the same 100-year lake level as the shoreline. Rainfall affects on river flooding was not part of this analysis.
- The smallest area evaluated for flooding was 0.25 acres. Non-flooded (dry) areas that were greater than 0.25 acres were preserved. Areas smaller than 0.25 and intersecting the flood hazard limit were merged into the flood hazard limit polygon.
- The CPR railway (located south of the CNR railway) is the southern limit of the analysis. No flood polygons were provided south of this limit.

Refer to Section 4.2 for maps illustrating the flood hazard limit.

4.1.3 Dynamic Beach Hazard Limit

The dynamic beach hazard limit is defined as the 100-year flood level, an allowance for wave uprush, plus a 30 m allowance to account for the dynamic nature of the beach and dune system, including periods of erosion and accretion. When the Conservation Authorities map their regulated area, an additional allowance of up to 15 metres can be added to accommodate the dynamic beach hazard limit (refer to Figure 4.4).

Figure 4.4 Dynamic Beach Hazard Limit



In GIS, only beaches with a minimum length of 100 m and a minimum width of 10 m were considered as dynamic. They must also be at least 0.3 m thick. The only beaches that met these criteria were the fillet beaches adjacent to Belle River marina.

The fillet beaches at Belle River were completely within the flood hazard limit. As a result, the dynamic beach hazard was limited to the backside of the beaches (the inland limit of sand and beach adjustments).

Refer to Section 4.2 for maps illustrating the dynamic beach hazard limit.

4.2 Mapping and 3D Visualizations

A map template was developed to visualize the hazards on full size 24 by 36-inch maps. Each map includes a summary of the hazards, base mapping, definitions, data sources, a PGO and PEO stamp, a disclaimer, and the tile index. Refer to Figure 4.5 for a sample of the template for Map 2 (of 35).

A tile index (i.e., continuous map panels) was prepared to provide complete coverage of the shoreline in the study area. Figure 4.6 provides an overview of the 35 tiles needed to map the shoreline of the Municipality of Lakeshore. In several location, such as Crystal Beach Road and Lighthouse Cove, the extent of the coastal flooding for the 100-year lake level extends more than 1 km inland. While these areas are not completely covered with the original 35 map tiles, the digital mapping is available for viewing with a GIS software platform and should be consulted for regulatory decisions pertaining to new development proposals.

Figure 4.5 Example of Map Tile

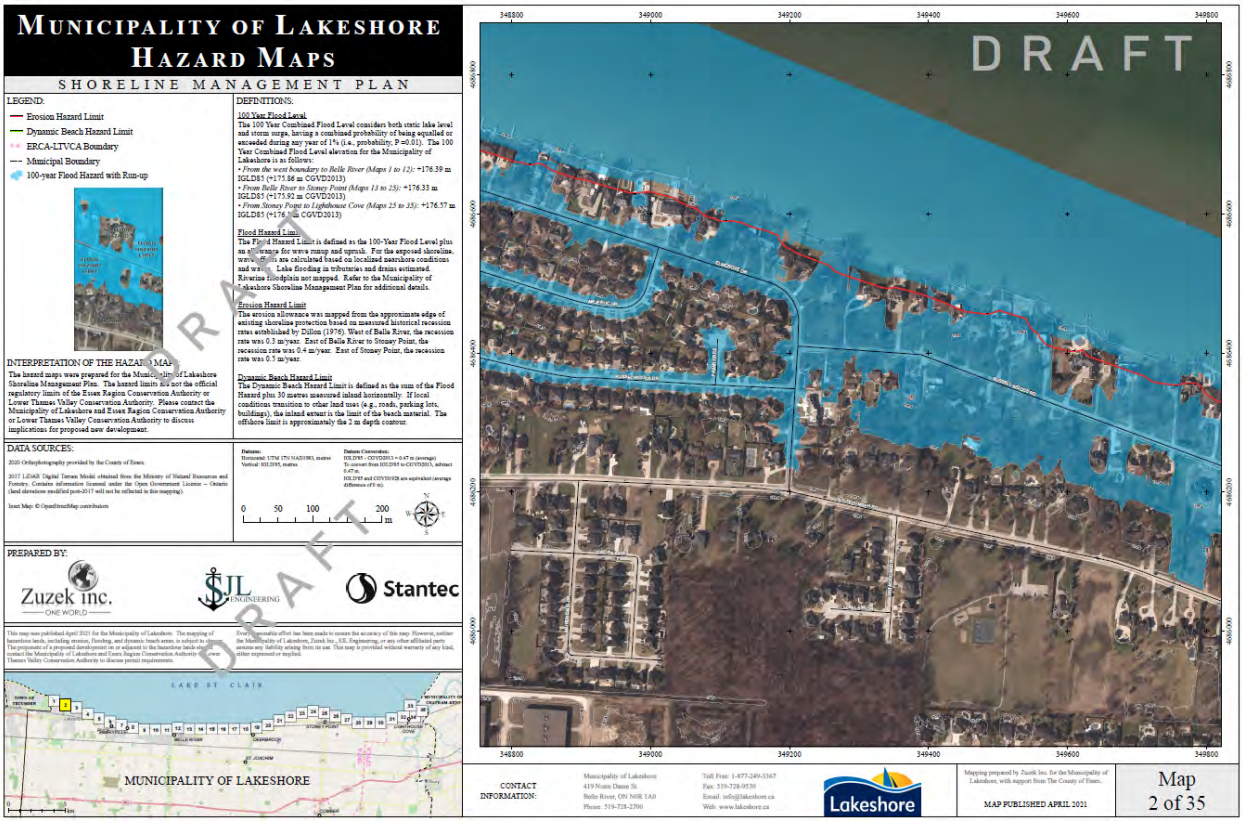
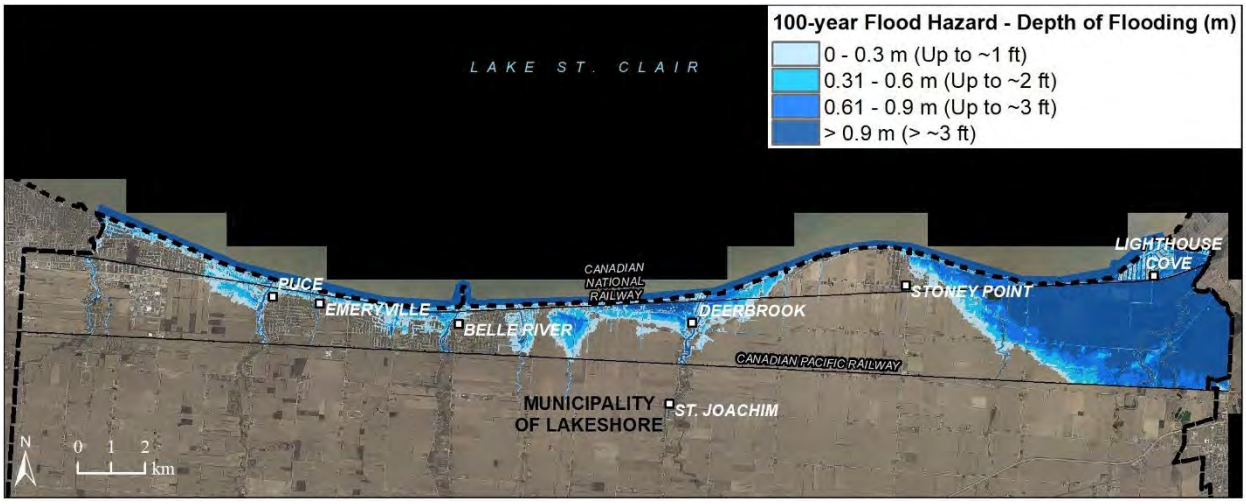


Figure 4.6 Map Tile Index

4.3 Depth of Coastal Flooding in Lakeshore

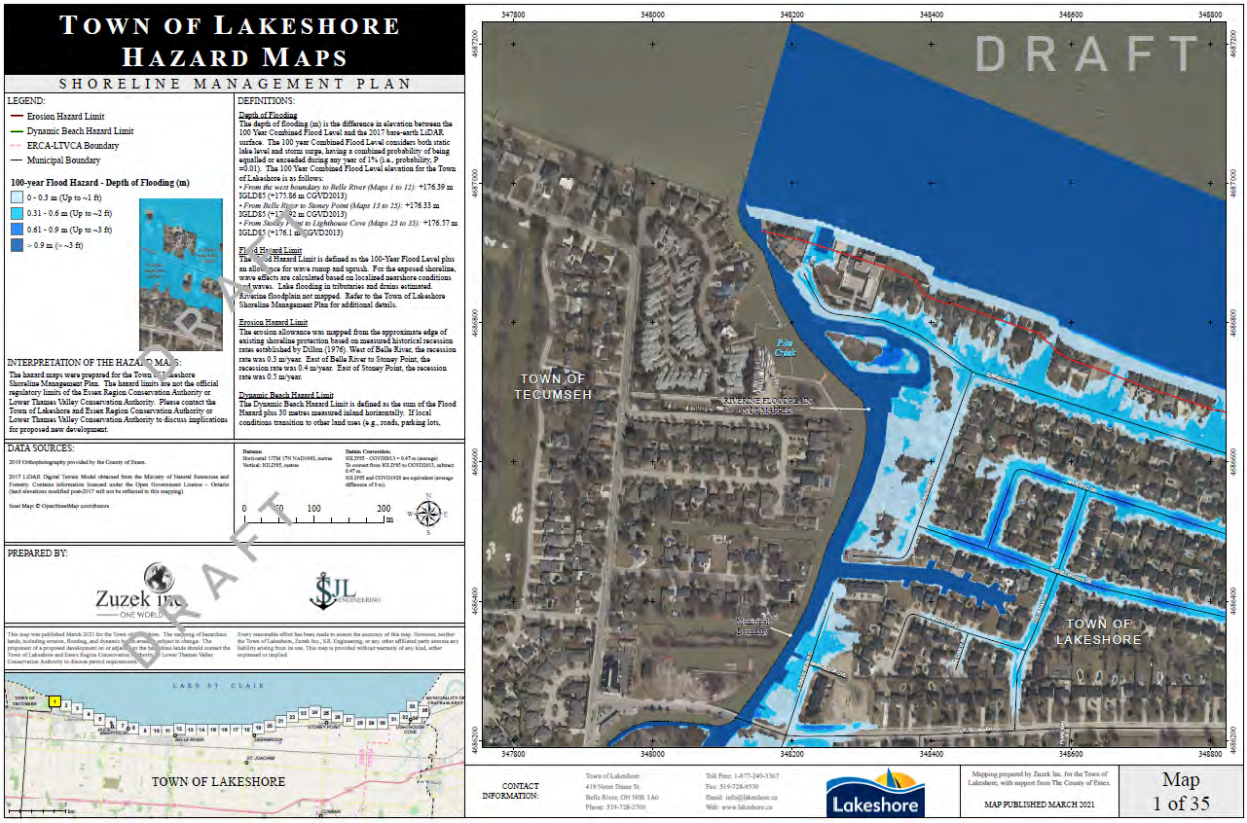
The depth of flooding within the flood hazard limit was estimated using the 2017 LiDAR elevation surface and the flood hazard limit for each of the three zones (West limit to Belle River, Belle River to Comber Side Road, and Comber Side Road to East Limit). In GIS, the flood hazard limit polygon was converted to a surface and assigned the value of the 100-year flood level, as this elevation determines the inland extent of flooding. The 2017 land elevation was then subtracted from the flood hazard level, resulting in a depth of flooding surface. This process was completed for the three zones listed above. The spatial extent of the flooding and the depth of flooding surface is presented in Figure 4.7 for the study area, which is bound by the Canadian Pacific Railway in the south (flooding may extend further south and be influenced by riverine processes which were not considered for this investigation). As discussed in Section 4.2, the inland extent of the flood hazard limit extends more than 1 km south of the shoreline in several locations, most notably from Stoney Point to Lighthouse Cove.

Figure 4.7 Depth of Flooding (to southern study limit, CP Railway)



Map 1 of 35 for the depth of flooding series is presented in Figure 4.8 for the western study limit adjacent to Pike Creek. The flood depths are visualized in increments of 0.3 m. Depths greater than 0.3 m can impede emergency ingress and egress for vehicles. As seen on the map, some of the roads feature water depths in the range of 0.61 to 0.9 m. Further analysis of this mapping product by the Lakeshore first responders is required to identify inaccessible roads and communities based on their vehicle limits for driving in a flood.

Figure 4.8 Depth of Flooding Hazard Map



4.4 3D Renderings of Flood Risk

Three dimensional (3D) renderings were generated at three locations to visualize the extent of the flood risk in Lakeshore for the 100-year lake level and the 100-year climate change lake level. The visualizations were produced for three high density areas, including Pike Creek, Puce River and Belle River. A total of three water levels were visualized at each location:

- Average Summer Water Level: 175.2 m
- 100-year Lake Level: 176.39 m
- 100-year Climate Change Lake Level: 176.77 m

The renderings were generated using sophisticated, technical software that incorporated high-resolution topographic data to represent actual land and water level elevations. Aerial imagery is draped over the land elevations and supplemented with

3D features, such as trees and buildings. The extent and spatial distribution of flooding is commensurate with that which is shown in the flood maps featured in in Section 4.3.

The first sequence of images was generated looking southwest at Pike Creek and is presented in the following figures:

- Figure 4.9 – Pike Creek during non-storm conditions with an average summer water level of 175.2 m IGLD'85.
- Figure 4.10 – Pike Creek during the 100-year lake level of 176.39 m IGLD'85.
- Figure 4.11 – Pike Creek flooding during the 100-year climate change lake level of 176.77 m IGLD'85.

Refer to Appendix F for the renderings at the Puce River and Belle River. The renderings highlight a key finding from the study: 1) the Municipality of Lakeshore has extensive coastal flood exposure based on historical extremes (e.g., 100-year lake level), and 2) climate change will make people, buildings, and infrastructure more vulnerable. For example, emergency access is already limited by road flooding and climate change will make even more communities inaccessible during a flood.

Figure 4.9 Pike Creek 175.2 m (average summer water level)

Figure 4.10 Pike Creek at 176.39 m (100-year Lake Level)

Figure 4.11 Pike Creek 176.77 (100-year Climate Change Lake Level)

5.0 Shoreline Management Recommendations

The shoreline management recommendations are summarized in Section 5.0. The Municipality of Lakeshore has acute flood hazard risks along the shoreline and in the river mouths. Consequently, access for standard emergency vehicles (e.g., fire, ambulance, police) is compromised for many parts of the study area during the 100-year lake level. During times of flooding, vehicles and people have no way of safe ingress and egress. In other words, residents may not be able to evacuate safely, and first responders may not be able to reach people in need.

Another notable trend throughout the study area is the age of the development and relationship to flood risk. In locations where new construction has occurred on regulated lands, the Conservation Authority have been successful at ensuring the new buildings are elevated above the 100-year lake level. Refer to Figure 5.1 (plan view mapping and oblique aerial view, where two new homes are protected from the 100-year lake level (left), while older development is inundated.

Figure 5.1 New Homes Properly Flood Proofed and at-risk Older Development (left mapping of the Flood Hazard Limit and right oblique photo)

5.1 Shoreline Reaches

The study area shoreline has been sub-divided into seven reaches to further evaluate coastal hazards, risks, mitigation alternatives, and recommendations for shoreline management. The reach boundaries were delineated by major physical boundaries, such as the rivermouths in the west, and the distinct coastal communities in the east (e.g., Stoney Point, Crystal Beach, and Lighthouse Cove) and varying flood risk. The reaches include:

- Reach 1: Pike Creek to Puce River
- Reach 2: Puce River to Belle River

- Reach 3: Belle River to Ruscom River
- Reach 4: Ruscom River to Stoney Point West
- Reach 5: Stoney Point East
- Reach 6: Crystal Beach Road to Couture Beach Road
- Reach 7: Lighthouse Cove

5.2 Hazard Mitigation Approaches

Four general hazard mitigation approaches were considered for the Shoreline Management Plan, including:

- **Avoid**: reduce future exposure by ensuring new development does not occur on hazardous land. The existing development setbacks for erosion and flooding embrace the principles of 'avoid' and are based on a 100-year planning horizon, as per provincial policy. Adopting a longer planning horizon would increase the longevity of the "avoid" strategy and the overall resilience of the shoreline. Avoid is an effective strategy for new development but does not address legacy development, where vulnerability to coastal hazards can be significant. This is particularly relevant for Lakeshore, since much of the older development along the lake is flood prone. Another challenge faced by communities across Ontario is the projected increase in the 100-year lake level due to climate change. To build resilient coastal communities requires a long-term perspective and consideration of future extremes when applying the "avoid" strategy.

- **Accommodate**: an adaptive strategy that allows for continued occupation of coastal properties while changes to human activities or infrastructure are made to reduce coastal hazards and vulnerability. For example, raising the foundation of a flood-prone building will reduce vulnerability and future flood risks. Refer to the adjacent example where a home was raised onto a new higher foundation. When considering "accommodate strategies", the potential for negative impacts to adjacent properties must be evaluated, concepts must be consistent with local zoning, and all agency permits are required. Innovation is encouraged with this strategy, provided solutions are safe and consistent with regulations. For example, float homes are currently not permitted in the Municipality of Lakeshore

and not appropriate for the energetic wave climate on Lake St. Clair. Furthermore, the consideration of 'green infrastructure' to reduce flood risk and the incorporation of flood hazard management measures into the design of these communities (i.e. parks, open space, fire creaks, naturalized areas) may have beneficial results, provided development is consistent with provincial guidance.

- **Retreat/Re-align**: a strategic decision to withdraw or relocate public and private assets exposed to coastal hazards when the costs to accommodate or protect are either not affordable, fail to produce a positive benefit-cost ratio, fail to adequately reduce the risk, or are not permitted due to regulations or legislation. This strategy is viable on a lot-by-lot basis and has been used successfully on the eroding bluff shoreline of Lake Erie (Zuzek Inc., 2000). It is also applicable at the community scale for infrastructure (e.g., roads) and buildings, but will require extensive consultation and possibly land acquisition from willing sellers. The retreat/re-align strategy may also require substantial funding to restore the formerly floodprone lands.

- **Protect**: the traditional approach to protect people, property, and infrastructure. Protect has been used extensively along Lakeshore's shoreline, with the amount of shoreline armouring ranging from 69% to 94% across the reaches. Examples include grey infrastructure such as armour stone revetments and seawalls, flood berms and levees, and nature-based solutions such as building coastal dunes, planting vegetation, and artificially nourishing beaches. Structures such as seawalls and armour stone revetments should be designed by a qualified engineer and constructed based on the details and specifications included on stamped engineering drawings. The proponent is required to secure all necessary construction permits and environmental approvals for the Protect options.

5.3 Recommendations for Shoreline Reaches

The recommendations for the shoreline have been summarized in reach templates in Appendix G. The template includes the following information:

- **Local Conditions**: The shoreline is described including important infrastructure and natural features.

- **Depth of Road Flooding and Emergency Access**: The flood hazard mapping, specifically the depth of flooding, was used to access the potential impacts of road flooding during the 100-year lake level.

- **Summary of Natural Hazards**: The applicable long-term erosion rate and 100-lake level is provided for each shoreline reach. The flood hazard limit was mapped with the 100-year lake level. To put the current risks in perspective, the

projected impact of climate change on the 100-year lake level is also noted in the reach summaries (e.g., higher by 0.38 m).

- **Summary of Flooding and Erosion Threats**: The hazard mapping was used to identify critical flood and erosion vulnerabilities in each shoreline reach.
- **Existing Shoreline Protection Structures**: The shoreline protection database is summarized for each shoreline reach, including the percentage of shoreline armoured versus natural, the type of existing shoreline protection structures, and an assessment of the level of design and structure condition.
- **Recommendations for Shoreline Protection Structures**: Based on the summary statistics, reach specific recommendations are provided including the need for community scale solutions.
- **Shoreline Management Recommendations**: The reach summaries conclude with overall shoreline management recommendations.

5.3.1 Recommendations for Shoreline Protection Structures

The following provides a summary of recommendations by Zuzek Inc. for shoreline protection structures to protect life and property from natural hazards along the shoreline. To understand which recommendations, apply to which shoreline reach, please refer to the templates in Appendix G.

a) Unprotected properties should be protected with engineered shore protection to reduce risk of erosion and flooding hazards, including propagation of coastal flooding inland. Options include berms or levees, beach systems with sufficient crest elevations to mitigate wave overtopping, removable flood barriers, revetments, and seawalls.

b) Raising the crest of existing shoreline protection structures is an effective mitigation strategy for wave overtopping and interior flooding. Another common mitigation approach is the construction of a rock berm at the base of existing vertical walls to dissipate incoming wave energy before it leads to wave overtopping at seawalls. Permits for in-water work will be required.

c) Natural beach shorelines provide desirable access to the lake but are low lying and contribute significantly to the flood risk in Lakeshore. Berms or dikes should be constructed landward of the sand beaches to reduce flood risk. Beach nourishment may also reduce flood risk during coastal storms.

d) Other shoreline protection options to reduce wave overtopping and flooding include the addition of a return wall, a new stepped crest, or a secondary wall further inland.

e) Future studies should establish standard engineering design criteria for shoreline protection structures along the lake and riverbanks to reduce wave overtopping volumes and wave uprush, which contributes to lakeshore and interior flooding. Figure 5.2 and Figure 5.3 provide examples of general guidance on toe and crest elevation for shoreline protection structures to achieve overtopping standards for the 100-year lake level of (176.39 m, IGLD'85 representative of Pike Creek to Belle River).

f) Failed shore protection should be repaired to provide a continuous barrier to coastal flooding. Repairs can use conventional engineering methods such as seawalls or revetments, or integrate hybrid approaches such as berms, living shoreline, and other nature-based solutions.

g) All sandbags and temporary geo-bags should be removed from the shoreline when a permanent engineered solution is installed.

h) Given the severity of the residential and road flooding, a continuous community scale shoreline protection plan should be pursued on a reach-by-reach basis, with uniform design criteria and 100% participation by landowners to increase resilience to coastal flooding and higher lake levels due to climate change.

i) The shore protection between the terminus of Crystal Beach Road and Couture Beach Road should be monitored, as it is the last line of defence from erosion for the CNR tracks.

Figure 5.2 Relationship between Toe and Crest Elevation for Sloping Shore Protection (1.5H:1.0V)

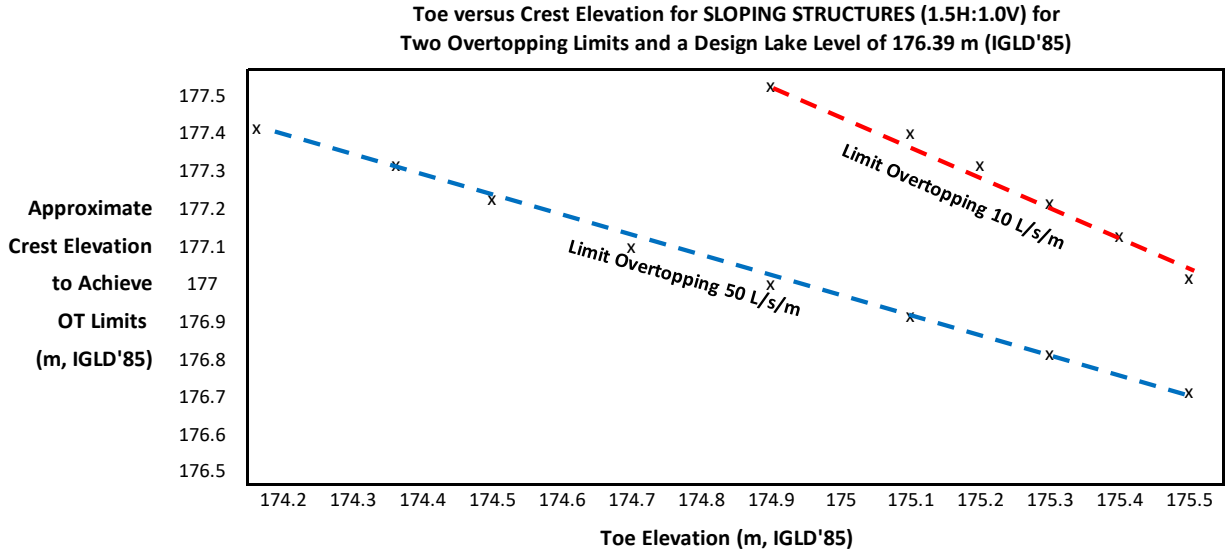


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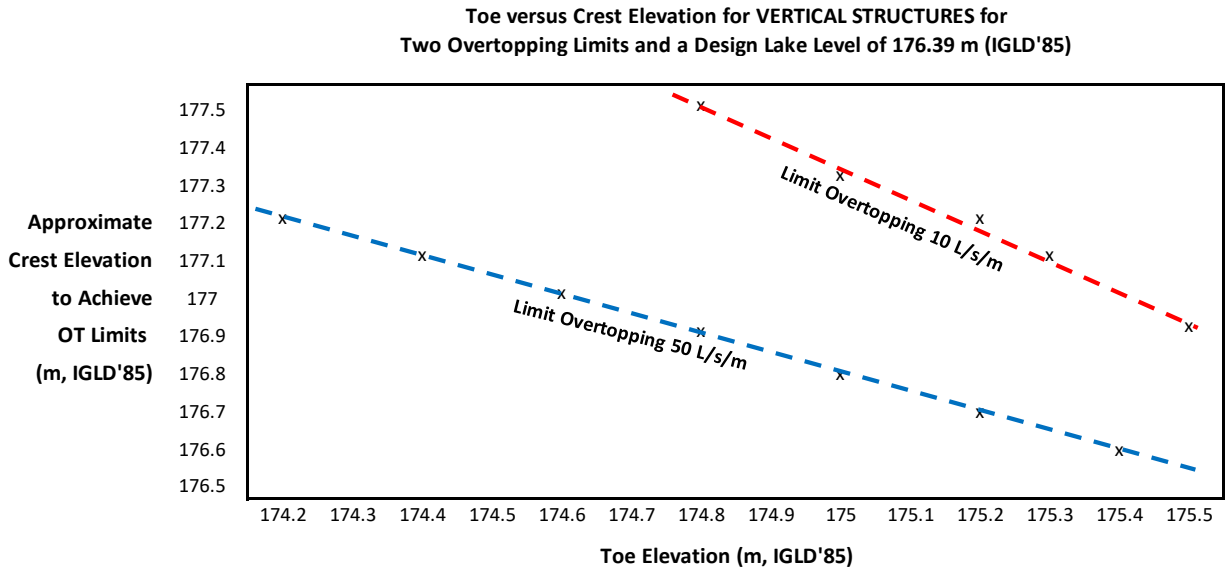
Figure 5.3 Toe and Crest Elevation Relationships for Vertical Structures and a Design Lake Level of 176.39m IGLD'85



5.3.2 Shoreline Management Recommendations

The following provides a summary of the shoreline management recommendations provided by Zuzek Inc. to protect life and property from natural hazards along the shoreline. To understand which recommendation(s) apply to which shoreline reach, please refer to the reach templates in Appendix G.

a) The “Avoid” approach is the most effective long-term approach to limit further development on hazardous lands and should be the cornerstone of land use planning on undeveloped lands within the Municipality of Lakeshore.

b) Adopt standard engineering criteria for shoreline protection structures, including crest elevation, and flood mitigation requirements for lakefront and riverfront properties. Leverage the results from this study to evaluate cost-effective long-term shoreline protection options that also enhance access to the waters edge (if desired by landowners) and improve local habitat. Pursue community scale solutions for the flood prone areas at a reach scale to increase resilience to coastal hazards with continuous shoreline protection and flood mitigation.

c) A reach- or community-scale program to flood proof existing vulnerable buildings is required. For example, foundations and lot grades can be increased if the proposed changes are consistent with Conservation Authority Regulations.

d) Further assessment of emergency vehicle access during the 100-year lake level and the 100-year climate change lake level is required, as water depths range from 0.3 m to 0.9 m in the study area. An emergency response plan is needed if vehicle access is not possible in these areas.

e) Planning for future development should not proceed on hazardous lands unless emergency vehicle access is attainable during the 100-year lake level and during the 100-year climate change lake level, as per Section 3.1.2 of the Provincial Policy Statement 2020.

f) Failed or low-crested shoreline protection should be upgraded based on new reach-scale standards.

g) A long-term strategy is needed to protect the shoreline and wetlands of Ruscom Shores Conservation Area with a nature-based approach, such as a headland beach system. An offset exists between the armoured shoreline of Surf Club Drive and the eroding shores of the Conservation Area. Without action, this offset will get worse with time, leading to more habitat loss and erosion risk for the adjacent residential development.

h) Shorelines with natural beaches can be flood proofed with berms/levees, beach nourishment, and dune construction to maintain access to the waters edge, provided it is part of continuous protection in the reach.

i) The municipality and Conservation Authorities should develop materials and recommendations to help homeowners flood proofing existing residential buildings. This should be done in conjunction with the applicable conservation authority to ensure consistency in requirements and streamlined approach the issuance of permissions under the Conservation Authorities Act and the Ontario Building Code.

j) Private septic systems that are inundated during the 100-year lake level should be upgraded. If upgrades are not possible, a plan to retreat and re-align the land use should be developed with the community.

   Prolonged periods of high lake levels can negatively impact other infrastructure, such as roads, water mains, and sewers.

   Long-term Municipal strategies are required to deal with these maintenance challenges.

5.3.3 Long-term Monitoring Recommendations

Moving forward, monitoring of the shoreline and future flooding impacts should be coordinated between the Municipality of Lakeshore and the Essex Region Conservation Authority and Lower Thames Valley Conservation Authority. Based on the technical

studies completed and results of the hazard mapping, the following monitoring recommendations are provided:

- Develop a lot-by-lot database of the crest elevation for existing shoreline protection structures to identify locations with high wave overtopping and flooding potential during storms.
- Identify low-lying unprotected lots that represent flooding vectors from the lake and work with landowners to develop community scale flood mitigation approaches.
- Map the spatial extent of future flooding events and compare to the flood hazard mapping generated for this study to verify the results.
- Monitor erosion hotspots along the shore, such as the eastern end of Crystal Beach Road. Specifically, the stability of the existing shoreline protection should be observed annually or after major storm events by a qualified engineer. The Canadian National Railway should be notified and involved in the annual observations.
- Complete future nearshore monitoring to compare lake bottom elevations collected for this study to future conditions.
- Monitor future shoreline erosion rates and wetland health in protected areas, such as the Ruscom Shores Conservation Area and Tremblay Beach Conservation Area. The monitoring results will inform the design of a long-term shoreline restoration plan for the two natural areas.

5.4 Land Use Planning and Zoning

The analysis conducted for this report and the updated hazard mapping reveals the serious threat to property, structures, and potential for the loss of human life when development occurs on hazardous lands. Proactive planning and zoning, that aligns with the existing Conservation Authority regulatory framework, can identify hazardous lands and assist with locating future development away from the risks, leading to safe and sustainable development. This section aims to provide informed recommendations to begin adapting the community with progressive and incremental changes that can start immediately and support adapting to the impacts of climate change over time.

The SMP recommendations are provided for the seven shoreline reaches in Appendix F. The Municipality of Lakeshore and all stakeholders should prioritize actions and take action at the community scale on the most vulnerable reaches. Establishing priorities

may require further risk assessment, such as calculating the economic damages associated for the 100-year lake level flood, social considerations, and potential environmental degradation.

Upon review of other available land use approaches to shoreline management, as outlined in Section 3.3 of this Report, it became clear that to address currently vulnerable communities, where there is an unacceptable risk to public health or safety, a multi-fold approach is necessary.

It is important to note that the concepts identified herein help explore the range of possible alternatives to mitigate natural hazards. Their applicability at a local scale or on an individual lot will require further investigation by landowners. For instance, they must be consistent with existing regulatory and zoning by-laws.

The “Avoid” approach to shoreline management in which land use planning controls restrict development in areas of moderate to high risk will be the primary recommended approach for Lakeshore. This section will introduce various planning tools that can be employed in Lakeshore that may result in the creation of ‘no build’ areas, restricting development potential on vacant and/or underutilized lands. An “Avoid” strategy may also include land acquisition or restrictive tools, such as land trusts. As much of the existing coastline of Lake St. Clair has been developed, the “Avoid” tactic alone will not provide enough protection against the increased coastal risk identified in this Report.

Additional approaches to “Protect” and “Accommodate” the increased flooding risks are also recommended to ensure existing development can be more resilient to the anticipated coastal vulnerability of the communities of Lakeshore. Many of these approaches involve engineering solutions that have been outlined in Section 5.3 of this Report, but some relate to the long-term management of land, and should therefore be reflected in, and guided by, local land use planning documents. Some of the typical approaches to “Accommodate” may not be permitted under the current technical guidance of the Province of Ontario; therefore, these approaches should be evaluated at a lot-by-lot basis for consistency with applicable standards and by-laws.

A Managed Retreat or the “Retreat” approach is a long-term vision for a community that plans for the eventual relocation of buildings and infrastructure to areas of lesser (or no) risk. Options for exploring this strategic direction have also been outlined in the recommendations of this section, focusing on areas where sensitive and/or critical uses and infrastructure are located in highly vulnerable areas of Lakeshore’s coastline.

The principal risk during the coastal flooding events are the dangers to infrastructure, buildings, and threats to human safety. For the purposes of simplifying the coastal hazards to the existing community that have been identified in this Report, the following risks in relation to the Lake St. Clair shoreline flood hazard are discussed within this section:

1) Shoreline flooding hazard, as determined by the existing 100-year flood level (as defined by the PPS) is referred to as the “100-year flood”;

2) Shoreline flooding hazard, as determined by the 100-year climate change flood level (as identified through this Report) is referred to as the “100-year climate change flood”;

3) 100-year erosion rate of the shoreline (as defined by the PPS and identified through this Report) is referred to as a the “erosion hazard”; and,

4) Areas rendered inaccessible to people and vehicles during times of the hazard events of 1-3 above are discussed throughout this Report and determined to include areas normally accessed by roadways (directly or indirectly) that are anticipated to be inundated with over 0.3m (~1ft) of water during the 100-year flood. The inability to access private and commercial property by first responders (fire, ambulance, police) during a coastal flooding event is a key challenge. Ingress and egress by residents are also limited for much of the study area.

These coastal threats, as specified by these four risks, are considered throughout Section 5.4. This section provides high level guidance around the type of land uses to be developed and approved through the Official Plan and in the Zoning Bylaw through the implementation of the SMP.

Section 5.4.1 identifies the Official Plan and guiding land use considerations, where the type of appropriate land use and high-level considerations for growth, as well as shoreline management approaches, can be defined in policy and strategic documents. Section 5.4.2, Zoning Considerations, outlines where the necessary regulations, as determined by the municipality’s Zoning By-law, can be determined and implemented, with overarching direction for possible design standards. Section 5.4.3, Mapping Considerations, provides an overview of the applicable maps and schedules to be revised through the outcomes of this study.

It is important to note that the next steps outlined in this report guide future considerations and recommendations for next steps. Upon consultation with the technical advisory committee, conservation authorities with jurisdiction, various stakeholders, the public, and Council, the high-level recommendations contained herein may be implemented to provide immediate action to begin to increase Lakeshore’s coastal resilience.

5.4.1 Official Plan / Land Use Considerations

As the most recent Official Plan Review for the Municipality of Lakeshore was completed in March 2021 and is pending County approval, the scope of the recommendations contained herein provide direction which can be used to inform a

subsequent amendment to the OP that specifically addresses shoreline flooding hazard policies for the coastline of Lake St. Clair, as part of the overall policy framework for development within areas determined to be natural hazards lands as identified in Section 5.4.1 of the Municipality of Lakeshore's Official Plan.

A significant issue with regards to implementation of the technical analysis prepared through this Report is the lack of clarity in the Provincial Policy Statement (PPS) when determining the Municipality's requirement to prepare for the 'impacts of a changing climate' (PPS 2020, 3.1.3) paired with the definitions of 'flooding hazards' for Great Lakes shorelines, which has not been updated to reflect the expected increases to lake level rises that are anticipated as a result of climate change, as analyzed in Section 3.0 of this Report. As the difference is 0.38m (38cm) between the two possible shoreline flooding hazard base flood levels, it does not represent a vastly significant addition to water inundation during a time of flooding, but it does potentially render additional roadways unpassable during flood events with the introduction of over one foot of water, which is an important consideration for the management of future land uses.

With that said, the 100 year flood level mapping presented in this Report (without climate change being considered) represents a major change in the existing hazard mapping of Schedule "B-4" Natural Hazards and Floodprone Areas, in particular the Lake St. Clair Floodprone Area. Larger regions of the coastline are inundated with water in this modeling, additional roadways will be rendered inaccessible, and the inland impacts on existing development are shown to increase. Therefore, it is imperative that the Municipal Official Plan be updated to reflect this impact in a timely manner. The 100-year Flood Level various by Reach area, and is summarized as follows:

- From the west boundary/Pike Creek to Belle River: 176.39m
- From Belle River to Stoney Point: 176.33m
- From Stoney Point to Lighthouse Cove/Thames River: 176.57m

The Mapping Considerations of Section 5.4.3 further define the process to provide specific direction for mapping and schedule updates.

The policy recommendations provided seek to achieve two aims. The first being that the natural hazard policies reflect the new 100-year lake level mapping to ensure development and site alteration not be permitted within the flood hazard nor within areas rendered inaccessible during times of 100 year flood events. The second being that the 100 year climate change lake level (and flood event) be identified as a significant coastal risk within Lakeshore and that the vulnerability of the coastline be examined when planning for growth and infrastructure in the long-term.

5.4.1.1 Natural Hazard Policies (Section 5.4)

As outlined in the Official Plan, areas characterized by flat topography, such as much of Lake St. Clair's shoreline, create a shoreline floodplain that is not often clearly definable. In low lying inland areas, it is assumed that flood waters tend to be shallow and of low velocity; although that is not necessarily the flood outcome the analysis presented in this Report determines. The flood hazard modeling outlines depths of over 0.9m (>~3ft) along vast areas of the Lakeshore shoreline (e.g., Reach 6 - Crystal Beach Road to Couture Beach Road). Consequently, the assumption of the 5.4.1 Pre-amble that the only major concern for these areas is property damage and impaired access; and that more opportunity for development is possible for inland floodprone areas should be reconsidered given the extent of the shoreline floodprone area determined through this Report. Furthermore, additional analysis may be required to determine if the cumulative impacts of the existing development patterns (e.g., building on higher ground) have led to problems with neighbouring property's ingress/egress by aggravating the flood hazard.

The policies of Section 5.4.1 of the Official Plan note that a reasonable compromise will be made between the extent of the hazard and the continued use and future development of the area, given the extensive residential development along the shoreline. This does not align well with the policies of Section 2.3.6 that state that development should be directed away from flood and erosion hazards. A recommendation of this Report will be to include stronger wording that protects people and property by discouraging any new development from the flood hazard and recognizes that the flood levels analyzed in this Report will form the basis to understand and plan for the extent of the flood hazard.

A clear statement should also be included in the Pre-amble that new development should only take place in areas that are not susceptible to hazards nor rendered inaccessible during times of flooding hazards. The corresponding policies should be clear that new development, even if floodproofed, should not continue to occur. There should be prohibitions to the conversion of agricultural areas to growth lands within the flood hazard.

5.4.1.2 Policies to Increase Coastal Resilience to Climate Change

The floodprone area, if defined as the 100-year climate change flood (with an increased lake level by 38cm), would extend beyond the floodprone/hazard areas determined in the technical mapping provided in Section 3.0 and **Appendix D** of this Report. Although the immediate focus of policy updates would be to implement the newly determined 100 year lake level as a natural hazard, it should be acknowledged through the Municipality's policy framework that the flood and erosion risks and vulnerabilities uncovered through this project would be exacerbated by climate change. An overlay

approach within the schedules of the Official Plan would serve as a screening tool to understand which lands may be unsuitable for particular uses within the Municipality, such as sensitive uses, hazardous lands, new or expanding infrastructure, and new or expanding settlement areas.

This overlay would be functionally similar to the Floodprone area (Presented as Section 5.4.1.3 of the Official Plan) but analyzed only during major land use and infrastructure decisions. This will provide specific guidelines for unsuitability of land use functions which expand those limited by the hazards. It should be clear that those lands which are developed within this overlay are subject to increased risk, may be subject to personal financial implications, and part of a public education/outreach initiative for landowners and/or prospective developers.

The Official Plan would also benefit from a new definition to provide clarity and transparency on the methodology for determining the overlay extent. Therefore, a new definition of ‘one hundred year climate change flood level’ is recommended to distinguish this potential risk area separately from the defined ‘flooding hazard’ of the one hundred year flood level, as defined by the PPS.

A policy framework for increased coastal resilience should be developed that seeks to achieve the aim of implementing Policy 3.1.3 of the PPS that requires planning authorities to “prepare for the impacts of a changing climate that may increase the risk associated with natural hazards”. There should be strong language in the Official Plan that the responsibility to implement Policy 3.1.3 should not be taken on solely by land use planning and/or as a reaction to specific development proposals. Rather, the OP should provide clear language that the additional coastal vulnerabilities of climate change will need to be proactively integrated into many municipal decisions, across various departments and sectors.

The specific policies to implement this direction could entail:

- Ensuring any proposed Official Plan Amendment that designates new growth lands (by change of use or settlement area expansion) be screened though the 100 year climate change flood level.
- Ensuring that any new or expanding infrastructure projects be screened through the 100 year climate change flood level to ensure that access could be maintained in this event.
- Review the policy-setting objectives for growth management to clearly communicate that the coastal risk of flooding should be a key consideration in the management of future growth within Lakeshore.
- Updating the Special Planning Areas section of the OP, Section 8.3, to ensure that any approved Secondary Plans completed for the communities of Lakeshore

should incorporate the 100 year lake level identified in the technical mapping of this Report, as well as have regard to the 100 year climate change flood level. Additionally, recommendations for structural/non-structural improvements within the corresponding Reach Summary (Appendix F) could be integrated into the strategic direction of each new Secondary Plan and/or updated Secondary Plan.

- Council reports from various departments that seek to further decisions about lands and resources could include a reference to how the decisions may intersect or be impacted by the 100 year climate change flood level. Much like municipalities are evaluating decisions through a 'climate change lens', Lakeshore could cater this evaluation specifically to this prominent/important coastal risk of shoreline flooding, and its main vulnerability when facing the consequences of a changing climate.

- Discourage/disallow basements and/or additional residential units and secondary dwelling units (detached or attached) within areas susceptible to the 100 year climate change flood level.

- Review hazardous sites, and the Human-Man Hazards, against the 100 year climate change flood level to ensure that long-term storage of hazardous material and any potential sites with contamination would not be subject to increased adverse effects in the event of such a flood.

- Review the location of existing institutional uses against the 100 year climate change flood level to ensure that site-specific emergency management plans and protocols are in place in the event of a flood.

- Review opportunities for targeting the restoration of natural heritage features and areas along the shoreline and refine supporting official plan policies to ensure that these aims can be funded through existing municipal financial tools (e.g., development charges, parkland dedication, community improvement programs targeted to restoration, etc.).

- Update the Lakeshore Official Plan to include the following definition as part of Chapter 8.8 Definitions.

  One-hundred year climate change flood level*: means, for the shoreline of Lake St. Clair, the peak instantaneous stillwater level, resulting from combinations of mean monthly lake levels anticipated to increase by a particular elevation due to current climate change projections and wind setups, which has a minimum of 1% chance of being equalled or exceeded in any given year. The particular elevation varies along the coastline, as follows: +176.77m from the west boundary to Belle River; +176.71m from Belle River to Stoney Point; +176.95m from Stoney Point*

to Lighthouse Cove (Source: Municipality of Lakeshore: Shoreline Management Plan, 2022, Table 3.2).

- Consider policies that speak to the Municipality and Conservation Authority with jurisdiction expediting the approval process in the event of a flooding or erosion emergency, where existing structures are at imminent risk (where feasible) to prevent damage from shoreline flooding.

A general opportunity for the Official Plan is to provide further guidance to the Transportation System (Section 7.2 of the Official Plan), through increasing the flood resilience of the transportation system. Policies related to Transportation System resilience would ensure that all residents and vulnerable users are able to shelter in place and/or protect property while maintaining access for emergency vehicles, evacuation and defensive deployment of flood mitigation. It is not recommended that the transportation system be upgraded as a precursor to allowing new development to proceed on lands susceptible to natural hazard, but as a reactive effort to ensure that existing residents and people maintain their anticipated emergency access routes in times of flood events. **Appendix F**, the Reach Summaries, also provide more detail on the specific routes and roadways that require priority attention in this matter.

The specific policies to implement this direction could entail:

- Requiring that arterial roads, which are within the shoreline flooding hazard, must be engineered to a standard through which they will not become inundated by the event to enable emergency access through a 100 year climate change flood event.
- All existing private and municipal roads within the shoreline flooding hazard be required to be resilient to a 100 year climate change flood event to a standard that would withstand such an event.
- All transportation infrastructure be designed to minimize the risk of capturing debris during a flooding event, which would prevent access.
- All communities that interact with the 100 year climate change flood mapping, through their respective secondary plans, are to have a minimum of one access route that is above the 100 year climate change lake level.

5.4.1.3 Municipal Land Acquisition

The municipal acquisition of lands to mitigate the impacts of the 100-year flood hazard would provide additional public lands with access to the lakeshore; however, these lands are very costly and provide a key attractor for seasonal and permanent residents, generate tax revenue and are home to the many lakefront communities that comprise the characteristic landscape of the lakefront. In accordance with Policy 5.4.1 e) there is

no requirement or public obligation to purchase any area within hazard lands; however, there may be circumstances where the social, economic, and health and safety risks for continued private use may outweigh the financial costs.

To that end, the purchase of lands due to flood risk should primarily be considered in the following circumstances:

- when a full parcel is completely covered by the flood and/or the erosion risk with a demonstrated instability of existing buildings.
- when the parcel contains a sensitive land use, such as day care centre, group home, senior's residence, etc., and is partially covered by the flood and/or the erosion risk with a demonstrated instability of existing buildings.
- when a critical infrastructure, such as a new dyke/seawall, is required in a specific location to provide structural protection for the health and safety of existing residents.
- when areas of the natural heritage system or other environmentally sensitive lands are vulnerable to the coastal hazard and/or their particular characteristics provide soft shoreline armouring as a means to mitigate the impacts of the flooding hazard.
- when the social benefit associated with the acquisition of private land protects the public interest, such as the creation of new park space.

A recommendation of this Report is to incorporate guiding principles for future land acquisitions into the policies of their Official Plan. No specific parcels have been identified within Lakeshore at this time, as the major areas of concern, as identified in the Reach Summaries of **Appendix F** are largely in public ownership. Parcels that are identified in the future, through more site-specific assessment such as secondary plans, should be used to leverage the public good, providing an appropriate use which serves the community and increases the overall community value.

Significant areas of erosion were noted, as opposed to some armoured shorelines. For example, see Crystal Beach with the areas in between the shoreline and the train tracks where a significant risk is shown (30-38m loss of land). A 0.3 to 0.5m per year recession of the shoreline was noted, based on information from Dillon (1976) and input from ERCA. The Reach Summaries in Appendix F identify portions of the study area that were emergency vehicle access will be limited by the depth of road flooding. In the future, emergency response planning should leverage the depth of flooding information generated for the study, local road network data, and information on emergency vehicle operation on flooded roads to map inaccessible communities.

5.4.2 Zoning Considerations

The Lakeshore Comprehensive Zoning By-law must comply with the intent of the Official Plan, therefore; the use of the updated 100 year lake level as the new flood hazard should be incorporated into the mapping, upon Conservation Authority review and approval. Therefore, an updated to the “Lake St. Clair Floodprone Areas” as identified on Schedule “A” should be incorporated into the existing Zoning By-law as a first and primary step for implementing this study.

With clear policies that no further future development should continue on hazardous lands, minor lot re-development within the newly determined 100 year lake level should be reviewed with the following considerations:

- There will be safe ingress/egress during the 100-year lake level. Site access should highlight the requirement to provide parking above the flood line, and property access which can both drain and meet the flood resiliency of the connecting road, as established by the Official Plan. Furthermore, there is a need to ensure that attempts to retrofit properties to obtain access do not negatively impact other areas, restrict, or redirect drainage;

- Development, if permitted, should preclude the development of occupied basements, bedrooms, utilities below the ground floor;

- During approved development and redevelopment, second floors should be rebuilt in a manner which is, at a minimum, the same square footage as the primary floor, to enable the storage of goods and material during a flood event without the necessity to evacuate it;

- All floors, through the use of balconies or similar, should be accessible to the outside, should occupants become inundated without opportunity to evacuate, to facilitate a base evacuation plan that landowners within the floodprone areas can edit for their use;

- No permanent structure be constructed within the erosion rate extent limit. Any buildings that are currently within the erosion rate limit, including accessory buildings, should be relocated outside of the erosion limit subject to rebuilds that are approved under the Technical Guide.

- Site drainage should be strictly controlled through Site Plan Control, where any improvements to the site cannot increase water retention or the overland flow towards an adjacent parcel.

5.4.3 Mapping Considerations

The policies and bylaws regarding natural hazards are to be applied when determining uses permitted on lands identified as Hazard Lands and illustrated as: the Limit of the Regulated Area; Lake St. Clair Floodprone Areas; and, Inland Floodplain Control Areas, as shown on Schedule “B.4” of the Municipality’s OP. **Figure 2.2** of the Report shows the extent of the Municipality’s shoreline outlining its previously mapped Natural Hazards and Floodprone Areas.

Revisions to the Lake St. Clair Floodprone Areas should be updated, once approved by the Conservation Authorities with jurisdiction, based on the floodplain mapping determined through this study. The 100 year lake level was determined to be the following:

- Shoreline Reach between Pike Creek and Belle River is 176.39m IGLD’85;
- Shoreline Reach between Belle River and Stoney Point is 176.33m IGLD’85;
- Shoreline Reach between Stoney Point and Thames River is 176.57m IGLD’85.

These lake levels should be incorporated into the updated layer for the “Lake St. Clair Floodprone Areas” or the Official Plans, at the County and local Municipality, as well as the Comprehensive Zoning By-law.

As a precursor to this amendment, the Conservation Authority’s regulated areas should be reviewed and updated with these updated lake levels to ensure that the technical components of the future administration of the policy recommendations are integrated into the CA’s regulatory reviews.

5.5 Grant Funding Recommendations

Previous recommendations made in relation to shoreline management and shoreline protection (Section 5.3.1 and Section 5.3.2) make note of the need for a community scale shoreline protection plan, with uniform design criteria, and the requirement for 100% community participation in order for the recommended measures to be successful. As some measures recommended for shoreline management and shoreline protection can be costly for landowners and there are joint benefits to the Municipality for improving the quality of existing shoreline protection structures, the Municipality may consider creating an incentive program for properties along the lakeshore to assist in protecting shoreline areas from flooding and other hazards. A community improvement plan could be created, and the entire Lakeshore shoreline could be included within the Community Improvement Plan Area (CIPA). Incentive programs could include funding

for the construction of shoreline protection structures (e.g., berms), moving of buildings further away from the shoreline, and flood-proofing buildings. Section 4.2.2 b) of the OP recognizes that CIPAs can be established to address “hazard land constraints such as flooding and/or erosion, where measures are designed to reduce the risk from natural hazards”. Therefore, there is existing policy support to implement this initiative.

The primary pathway for interior flooding in Lakeshore is wave overtopping and runup along private lakefront property. This flooding not only inundates waterfront landowners, but municipal assets and interior land owners. As such, the Municipality of Lakeshore may consider development a reach or community-scale application for funding from senior levels of government to increase the height and quality of private shoreline protection structures that would increase the protection to waterfront development and interior areas of the community.

Another option that the Municipality could consider is obtaining funding from the Canadian National Disaster Mitigation Program (NDMP) to create and implement a CIP and associated grant programs. The NDMP provides funding to municipalities to assist in preparing communities for flood disasters. In obtaining NDMP funding, the Municipality would be able to assist residents and landowners (through grants) with mitigation improvements to private property, while also investing in municipal mitigation projects for public owned lands.

Funding tied to the improvement of parks and open spaces in Ontario is also available through the Trillium Foundation, with opportunities such as the Community Building Fund – Capital Stream that provide municipalities with improved infrastructure for communities to thrive, allows for improvements to public spaces for additional accessibility, and to facilitate community member’s full participation in the life of the community. Access to open space, accessible waterfront trails, and improvements to public areas and buildings could be tied to reclaimable and restoration efforts of the shoreline.

5.6 Recommendations

The following recommendations are provided to take action on the findings in this shoreline management plan and reduce the vulnerability of the Municipality of Lakeshore to coastal flooding and erosion hazards:

- While the flood hazard limit was mapped with the 100-year flood level, the best available science indicates future lake levels will be even higher. Therefore, the Municipality should consider the impacts of a changing climate on future coastal hazard extremes in all planning and development decisions.

- Stop issuing permits for new development on hazardous lands or on lands without safe emergency access in all reaches. Stop approving new urban developments that use streets as temporarily storm water retention systems, as this limited safe ingress and egress during the 100-year flood level and is not consistent with Provincial Policy. Climate change is projected to result in future periods of lake levels even higher than those recorded in 2019/2020. This will make the emergency access problem ever worse in Lakeshore.

- Evaluate emergency ingress and egress on a reach-by-reach basis using the depth of flooding maps and constraints for emergency existing response vehicles (e.g., height of exhaust pipe above road surface). Identify inaccessible communities and develop appropriate adaptation/contingency plans to ensure emergency services can be delivered to the residents of Lakeshore and residents are able to evacuate during a flood. This may require engineered upgrades to the road network, or innovative, adaptation strategies such as updated emergency response vehicles

- Investigating the limitations of the existing emergency vehicle fleet and augmenting emergency response equipment could be completed in the short-term. Investigating the engineering feasibility of upgrading road infrastructure is likely a medium-term activity, with actual modifications occurring in the medium- to long-term (if feasible).

- The updated hazard mapping has identified vulnerable communities in all the shoreline reaches. The Municipality should consider additional risk assessment studies to quantify the potential social impacts and economic damages associated with future flooding, which will help prioritize actions on a reach-by-reach basis. Understanding the potential magnitude of the social impacts and economic damages will also put the required infrastructure upgrades in perspective (e.g., cost of avoided damages if all the shore protection in a reach is upgraded can be compared to the actual cost of the upgrades to develop a benefit-cost ratio). Additionally, providing template-based community scale ‘shelter-in-place’ plans for existing development where it is determined that there is no access and any future development is prohibited.

- Based on established priority areas, initiate further community scale studies (e.g., an individual reach) with stakeholders to investigate the feasibility and benefits of standardized shoreline protection criteria and upgrades, flood proofing measures for homes and other infrastructure, and develop appropriate implementation strategies.

- Develop restoration plans for conservation lands in partnership with the Essex Region Conservation Authority to protect and preserve these important public access nodes to Lake St. Clair.

- Monitor high-risk areas and the stability of existing shoreline protection structures that protect critical infrastructure (e.g., CNR rail line in Reach 6).
- Investigate riverine flood risk, including the impacts of climate change, and the joint probability of riverine and coastal flooding for the Municipality of Lakeshore.
- Integrate the findings of the SMP and hazard mapping into the Official Plan and Comprehensive Zoning By-law by updating the Lake St. Clair Floodprone Areas based on the determined 100 year lake levels, once approved by the Conservation Authorities with jurisdiction.
- Incorporate updated strategic policy directions identified in Section 5.4 of this Report, by revising the Municipality of Lakeshore Official Plan language of Section 5.4.1, Natural Hazards, pre-amble to reflect the following:
    - That the shoreline flood prone areas have concluded that water will be inundated much further inland than previous mapping suggests, and at greater depths. Therefore, assuming inland flood prone areas will be “shallow and of low velocity” is misleading.
    - That the cumulative impacts of existing development should be considered when determining if new development has the potential to aggravate the negative impacts to human life and property that the shoreline flooding and erosion hazards present.
    - That language suggesting that a ‘reasonable compromise’ can be made between the extent of the natural hazard and the continued use and future development’ of the shoreline area be amended to clearer identify that development is required to be directed away from the flood hazard (as well as other natural hazards).
    - That additional language be included to clarify that new development (regardless of whether it is itself proposed within a natural hazard), be only permitted to take place in areas not susceptible to hazard nor in areas rendered inaccessible during times of flooding hazards (either through direct or indirect roadway access).
- For proposals under the Planning Act (minor variances, site plans) on existing lots of record, where shoreline flooding hazards are now present and minor changes to a building may be currently permitted, the review of site in relation to not only floodproofing, but any ingress/egress routes, should be completed.
- Review overarching growth management policy framework of the Lakeshore Official Plan and County of Essex Official Plan to ensure that the policy-setting objectives and goals clearly communicate that the costal risk of flooding should

be a key/driving consideration in the management of future growth within Lakeshore.

- Review the identified growth lands as determined through settlement area designations of Schedule A of the Municipality of Lakeshore Official Plan and Schedule A.1 of the County of Essex Official Plan in relation to the flood risk mapping prepared as part of Section 3.0 of this Report to ensure all properties within settlement areas are accessible in the event of a 100-year climate change flood (e.g., have access and egress roadways with less than 0.3m inundation).
- In locations along the coastline where the Natural Heritage System, as identified on Schedule “B2-2” of the Lakeshore Official Plan, intersects with a 100 year climate change flood, as identified by this Report, work to investigate options for restoration opportunities with the goal to secure the long-term implementation of erosion prevention and the protection of the nearby rail line through non-structural adaptation. Additionally, enhanced opportunities for public access could be incorporated into restored coastal landscapes to algin with policies for increasing public access along shoreline. Note that the priority for such opportunities, based on the costal risk identified in this Report, could be targeted to the following areas:
    1. Tremblay Beach Conservation Area and Crystal Beach Road
    2. Ruscom Shores Conservation Area and areas east of the Ruscom River mouth
    3. Area west of Luken Marina and east of Mariners Drive
- Employ screening layer of the 100 year climate change lake level for sensitive screening of coastal resilience into strategic planning documents. This would include any new/updated Secondary Plans, major municipal infrastructure decisions, and any land acquisition and/or restoration programs.
- Review other relevant and governing master planning documents to ensure their alignment with the recommendations of this Report, including but not limited to the Stormwater Master Plan Phases 1 and 2.
- Improve the transportation system within the 100 year climate change lake level to ensure residents and vulnerable road uses are able to evacuate and deploy defensive flood mitigation, as necessary, while ensuring emergency vehicle access.
- Integrate potential land purchasing and/or acquisition policies into the Official Plan, as outlined in Section 5.4.1.3 of the Report.

- Work with Conservation Authorities (CA) with jurisdiction to update the CA Regulated Area in a manner that reflects the refined 100 year lake level, recognizing that the CAs currently regulate to the 100 year lake level (without climate change). Furthermore, ensure strategic planning documents of each Conservation Authority consider the 100 year climate change lake level.

The successful implementation of the new and updated strategic direction recommended within this Report will depend heavily on public education and a clear consultation process. The Public Information Centre (PIC #3) served to provide an introduction to the recommendations of this Report, but ongoing public outreach with stakeholders and the public will be a key driver of implementation.

Furthermore, it should be noted that the timelines for implementation of the recommendations of this plan require immediate action, without the expectation of immediate results. It will be a resource heavy and timely endeavor to make future steps to minimize Lakeshore's coastal risks and vulnerabilities. Cross-municipal partnerships with similarly impacted areas, joint implementation planning, and shared services and resources may be required for effective implementation of short and long-term recommendations.

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Appendix A Consultation Plan

Communication Plan

Town of Lakeshore

Shoreline Management Plan

September 22, 2020

Prepared for:

Town of Lakeshore

Prepared by:

Stantec Consulting Ltd.

TABLE OF CONTENTS

BACKGROUND + CONTEXT

The northern extent of the Town of Lakeshore consists of the Lake St. Clair shoreline and includes both serviced, and unserviced development areas. Each reach of the shoreline is subject to shoreline hazards (flooding and erosion). Currently, the Town of Lakeshore does not have a shoreline management plan for the reach of shoreline within the boundary of the municipality. The Essex Region Conservation Authority regulates development activities along the Lake St. Clair shoreline (through O. Reg. 158/06). The northern portion of the Town is also located within the Lower Thames Valley Watershed and is regulated under O.Reg. 152/06

The Town of Lakeshore has retained Zuzek Incorporated ("Zuzek") and Stantec Consulting Ltd. ("Stantec") to prepare the Shoreline Management Plan (SMP) for the Town of Lakeshore. The SMP will have regard for

- **Prevention** of new development from locating within areas subject to loss of life and property damage from natural hazards;
- **Protection** of existing infrastructure and development from natural hazards through the application of structural and non-structural measures (including acquisition);
- **Emergency Response** to prepare for emergency situations through flood forecasting and warning systems and implement appropriate emergency response procedures such as evacuating areas and disaster relief.
- **Public Information** to increase awareness of challenges and risks associated with shoreline hazards;
- **Environmental Conservation** to ensure that no adverse environmental impacts result from actions; and
- **Monitoring** the implementation of the Shoreline Management Plan and the effectiveness of the recommendations.

Engagement for the project plan will consist of three main phases – an initial engagement with stakeholders and the public to make introductions; engagement with stakeholders and the public to review draft objectives; and to present the final recommended options and draft plans to stakeholders and the public prior to Council consideration. A project website will also be created where members of the public will be able to interact with project information throughout the study.

This Communications Plan will create a framework for how the public and stakeholders will be engaged throughout the study, highlights key objectives for the engagement, and communications strategies.

MISSION STATEMENT

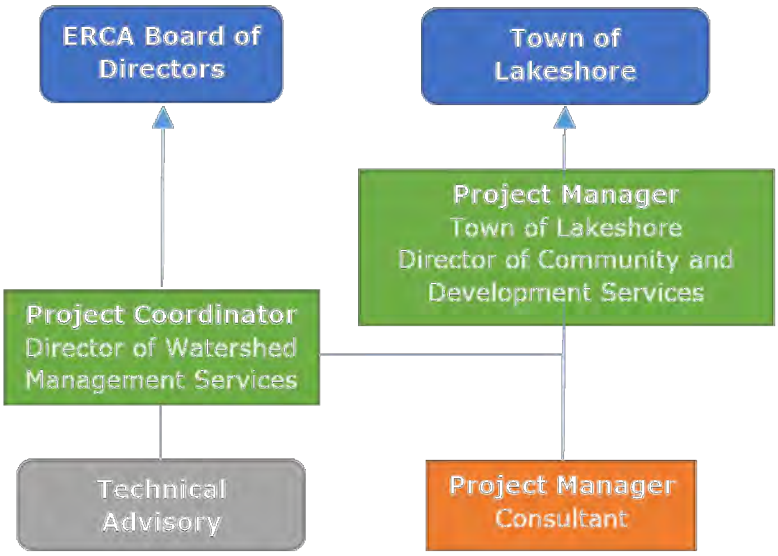
Stakeholder engagement will be open, inclusive, transparent, and dynamic. The project team, including Town of Lakeshore, Zuzek and Stantec staff, will strive to incorporate community priorities into the decision-making process, and articulating the . We acknowledge that achieving consensus is difficult and unlikely due to various stakeholders and interests, however the Communications Plan will provide the framework to encourage feedback that can be integrated into the planning process and communicated the benefits and trade-offs made throughout the project.

ENGAGEMENT FOCUS + GOALS

- To encourage community involvement in the project process through transparent and accessible engagement opportunities.
- To develop an understanding of the existing perceptions of issues and opportunities.
- To identify increase community awareness of challenges and risks associated with shoreline development.
- To document stakeholder input and validate involvement.
- To acknowledge, communicate, and educate stakeholders of the potential impacts of the study on land impediments and potential development barriers; and
- To craft recommendations that are reflective of stakeholder input and broadly supported.

COMMUNICATIONS APPROACH

The success of the Plan will require active input in buy-in from a range of key stakeholders, both internal and external to the project team. It is anticipated that a Technical Advisory Committee (TAC) will be convened and a Project Coordinator will be assigned to chair the TAC meetings and liaise with the ERCA Board of Directors.



Residents and property owners along within the study area, particularly along shoreline areas, will have significant interest in the development of the Plan and it is anticipated that the Plan will face significant interest by property owners due to the potential for perceived/real impacts to future development potential. Education will be a significant component of the communications plan for the study. The International Association of Public Participation recognizes a spectrum of community engagement activities with increasing levels of stakeholder authority in the decision making process:

Inform – Provide the public with balanced and objective information to assist them in understanding the problem, alternatives, opportunities, and/or solutions.

Consult – Obtain public feedback on analysis, alternatives and/or decisions. For example, this may be done through use of comment forums, focus groups, surveys, or public discussions.

Involve – Work directly with the public throughout the process to ensure that public concerns and aspirations are consistently understood and considered. For example, design studios, workshops, and deliberative interviews may be used to directly influence decision-making.

Collaborate – Partner with the public in each aspect of the decision including the development of alternatives and the identification of the preferred solution. This level of involvement may form a stakeholder advisory committee or mediation.

Empower – Place final decision-making in the hands of the public. This level allows the stakeholders to decide, through voting ballots or a delegated committee decision, for example.

This project team will endeavor to Inform, Consult, and to a lesser extent involve stakeholders throughout the process to convey information to landowners, elicit community support, and solicit feedback. We note that while community and stakeholder input is important to the study, the ability to influence decision-making is somewhat limited by the regulatory framework within which we are working. By the very nature of the project, the decisions of the shoreline management plan will be made by Council based on recommendations supported by scientific evidence and guided by regulatory policy.

KEY CONTACTS

Town of Lakeshore

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ROLE OF THE TECHNICAL ADVISORY COMMITTEE

The Technical Advisory Committee (TAC) represents the interests of the municipality, utility and transportation stakeholders, as well as the public as a whole with matters concerning public safety and emergency response, flood protection, environmental quality, conservation, among other aspects. The TAC will consist of subject matter experts, including key representatives from the Town of Lakeshore, the Essex Region Conservation Authority, Lower Thames Valley Conservation Authority, and the County of Essex Planning Division. TAC meetings will provide valuable input to the Project Team:

- to communicate local knowledge, guidance and expertise;
- to identify potential technical issues, constraints or impacts and confirm the work plan;
- to ensure that accurate technical information or resources are available or assembled; and
- to foster a positive working relationship between the Town, County, conservation authorities and external agencies.

ROLE OF THE PROJECT TEAM

The project team, including the consulting team and Town staff, will provide the overall guidance and accountability for the engagement process.

Town staff will be responsible for scheduling events, updating online content to the Town's website, distributing activity notifications, and providing oversight on activities and develop any key messaging, branding, or content deemed necessary.

The Town of Lakeshore Director of Community and Development Services, Tammie Ryall, will be the primary project spokesperson and the contact person in media releases pertaining to the project. Town Mayor, Tom Bain, should be quoted on media releases to lend political support and legitimacy to the project.

Stantec and Zuzek will develop materials for Public Information Centre (PIC) and may be asked to provide Town Council presentations, including presentations and poster board materials. Stantec will also design, deliver, and document the engagement activities. Stantec will be expected to provide event planning, communications, invitations, and logistics for PIC events, including:

- Draft and design invitations/notifications;
- Draft, design and produce poster boards; and
- Provide sharpies, sticky pads, name cards, etc.

ROLE OF THE COMMUNITY

Community engagement is critical as the SMP and recommended policy changes may affect landowners and the implications of any desired future development opportunities. Public engagement for this project is anticipated to be largely at the "Inform" and "Consult" level to convey information, educate the public of the outcomes and desired principles of shoreline management, and to obtain feedback at each phase of the project, while also allowing for some public and key stakeholder involvement in initial phase. Residents will

be acknowledged as “local influencers” that will help identify constraints and areas of concern in their own community.

ROLE OF THE FLOODING TASK FORCE

The Town of Lakeshore Council created the Flood Task Force to develop a plan to prepare for flooding events. The Task Force consists of community members and representatives from Council. As champions for flood preparedness and response planning within the Community, they represent an important stakeholder group for the SMP. They will be consulted during each phase of the study prior to consultation with Council and the Community in order to review and provide feedback on technical analysis and shoreline management approaches within the SMP.

ENGAGEMENT EVENTS + COMMUNICATIONS

Project communications will take on a dynamic and multi-pronged approach that will support the overall goals and objectives outlined in the Engagement Strategy, as well as the phase-specific goals outlined in this plan. The overall strategic approach will leverage a variety of communication channels to provide information and receive feedback including the following.

- **Public Information Centres** will be held in open house format to allow residents and stakeholders to congregate in a relaxed setting, with multiple opportunities for information sharing with other residents, industry professionals, and councilors if available.
- The **Town of Lakeshore website (www.lakeshore.ca**) that will function as a repository for project related information, notices, timelines and final documents.
- The Town has implemented new public engagement online software. **PlaceSpeak** will administer engagement opportunities and document public input automatically, which will be used in reporting.
- **Directed notifications (letters of invitation)** will be distributed to stakeholders prior to key events as a tool to inform and remind of upcoming public engagement activities.
- Advertisements placed the **local newspaper(s)** may be used to inform the broader public.
- **Report to Council** with regular updates.
- **Communicate through Councillors**, businesses and local organizations to spread information as broadly as possible.
- Updates using **social media** to advertise key project updates and engagement opportunities will be promoted by Town of Lakeshore accounts holders.

As the project progresses, communication and engagement will be evaluated at each phase. Any suggestions to improve communications are accepted and may be incorporated as the project continues.

This section outlines in more detail what activities and platforms are planned. Activities are intended to meet those communication and engagement objectives and commitments outlined in our strategy. Each of the three Phases in the process will actively engage stakeholders and the community, present new information and solicit their feedback. Each phase will also summarize what we’ve heard and how we intend to use that information, which may then be available at city hall and uploaded to the Town’s website and/or PlaceSpeak website to ensure a transparent engagement process, or provided to Council for their review, considerations.

PHASE 1: BACKGROUND REVIEW & CONSULTATION

ENGAGEMENT GOALS:

- Assembly of TAC and receive initial feedback from subject matter experts.
- General introductions to project team, subject matter experts and municipal staff.
- Introduction to the project framework, acquisition and review of available technical studies; and finalization of process.
- Seek advice from landowners and areas of concern.

ENGAGEMENT OBJECTIVES:

- To officially commence the project and communications, providing introductions to project team and project purpose/timelines, and planning/project process.
- To establish engagement expectations and "rules of engagement".
- To encourage project involvement and alternative avenues for providing feedback (e.g. website, survey, future events).
- To host a community Open House and individual meetings (or conference calls) where necessary with key stakeholders.
- To solicit feedback and perceptions of community (SWOT Analysis).
- To initiate an online presence to provide convenient access to information and a line of communication.
- To document all input received.

COMMUNICATION ACTIVITIES:

Technical Advisory Committee (TAC) – Meting #1: A kick-off meeting will be held with the identified Technical Advisory Committee. Due to the preliminary nature of this meeting, we propose that the meeting may be held as a teleconference. The Scope of Services shall be provided to attendees prior to the meeting for review and comment. The objectives for the meeting will be to ensure key stakeholders are in agreement with the work program and objectives moving forward.

Project Initiation Notice: Notice to be sent to community landowners to officially commence study, provide a web address to the Town's website and PlaceSpeak, contact information for key team members, and invitation to initial open house (PIC #1) meeting. Notice to be mailed in the form of a letter or postcard.

Flood Task Force Meeting #1 – The project team will attend and present at a Flood Task Force Meeting to introduce the project and solicit initial feedback on priorities and concerns.

Public Information Centre (PIC) – Open House #1: an event will be held to introduce the project and project team and solicit community feedback including perceptions of existing community (facilities and land uses). Initial meetings will introduce the purpose of the Secondary Plan and Community Improvement Plan, identify local constraints and opportunities (SWOT Analysis) and an extract a vision for the long-term community sustainability. A PIC Summary will be created to recap feedback received.

Online Platform: An online presence is ideal for those who are unable to attend the PIC event. Using out-of-the-box online software, such as PlaceSpeak, polls or surveys may be used to solicit information.

Available reports, information and project progress will be deposited online for review, maintaining transparent and convenient access to information. Links to access the content will be provided on notifications mailed to stakeholders and the Town's website.

Presentation to the Town of Lakeshore Council: To facilitate buy-in from key stakeholders, we have included a presentation to the Town of Lakeshore Council at the conclusion of Phase 1 in order to ensure they are informed throughout the study. A representative from Zuzek Inc. and Stantec will be in attendance to present Phase 1 findings and answer questions from Council.

DELIVERABLES:

- TAC Scope of Services
- Online content (e.g. resources, graphics, text).
- Notification letter to residents/landowners.
- Open House feedback forms
- Flood Task Force Meeting #1
- PIC #1 summary report.
- Council presentation #1

PHASE 2: TECHNICAL ANALYSIS

ENGAGEMENT GOALS:

- Produce new 1:100 Year flood extents and draft Hazard Mapping for review
- Produce preliminary land use policy best practices for review
- Summarize and communicate technical review/findings
- Elicit technical feedback from subject matter experts and TAC
- Gauge response to preliminary technical evaluations and receive feedback to aid in final policy recommendation(s)
- Maintain a transparent project plan

ENGAGEMENT OBJECTIVES:

- To update TAC and stakeholders on the technical analysis and work completed to date.
- To present flood Hazard Mapping and inform landowners and stakeholders of initial results and potential impacts.
- To continue an online presence and provide updated information, timelines, and concepts and receive public input.
- To document all input received.

COMMUNICATION ACTIVITIES:

Technical Advisory Committee (TAC) – Meting #2: A meeting will be held with the identified Technical Advisory Committee to review the 1:100 year flood mapping and hazard mapping. A discussion of overall impacts and issue/concerns will evaluate next steps, including information to be presented at PIC #2.

Public Notice: Notices to be sent to community landowners to advertise the second Open House to discuss and provide feedback on draft planning vision/objectives and conceptual options. Notice will also provide a link to the Town's website, engagement survey, and contact information for key team members. The Town's website and/or community engage platform will be updated to present new materials, technical information, draft vision and objectives, and conceptual design solutions.

Flood Task Force Meeting #2 – To present draft results of the hazard mapping and analysis, as well as discussion regarding shoreline management approaches.

Public Information Centre (PIC) – Open House #2: an event will be held to present what we heard at first open house, present conceptual design options, and solicit community feedback. A report will be created to summarize feedback received.

Presentation to the Town of Lakeshore Council: The results of Phase 2 technical analysis and policy recommendations will be presented to Town Council. Staff from Zuzek Inc. and Stantec Consulting Ltd. will be in attendance to answer questions.

DELIVERABLES:

- Updated information for online/website platform
- Notification letter to residents/landowners.
- Open house feedback forms
- Flood Task Force Meeting #2
- PIC #2 summary report.
- Council presentation #2

PHASE 3: SHORELINE MANAGEMENT PLAN

ENGAGEMENT GOALS:

- Develop and present Shoreline Management Concepts and draft SMP to TAC and stakeholders
- Develop and present recommended Zoning By-Law changes
- Gauge response to alternative flood mapping and receive feedback to aid in final recommendation(s).
- Maintain a transparent project plan

ENGAGEMENT OBJECTIVES:

- To update TAC with the draft SMP and regulatory/policy changes and finalize deliverables.
- To update stakeholders on the outcomes of the technical information of Phase 2 and the final revisions made to achieve the preferred mapping and policy recommendations.
- To continue an online presence and provide updated information, timelines, and concepts and receive public input.
- To document all input received and present to Council with the final draft deliverables and recommendations.

COMMUNICATION ACTIVITIES:

Technical Advisory Committee (TAC) – Meting #3: Draft reports will be distributed to the Technical Advisory Committee prior to the meeting for review and comment, as well as final revisions needed prior to Council presentation.

Public Notice: Notice to be sent to stakeholders to advertise the third Open House to discuss and provide feedback on draft SMP. The Town's website and PlaceSpeak will be updated to present new draft materials and PIC #3 information.

Flood Task Force Meeting #3 – To provide project update and draft Shoreline Management Plan recommendations for review and discussion.

Public Information Centre (PIC) – Open House #3: PIC #3 will be held to present the findings of phases 1 and 2, and the draft Shoreline Management Plan and Official Plan/Zoning Bylaw Amendments. This will be a crucial step in the process and will provide stakeholders with an opportunity to discuss the implementation of the Shoreline Management Plan through policy/development regulations. A report will be created to summarize feedback received. This report may be used to update Council with the feedback

Presentation to the Town of Lakeshore Council: The final draft SMP and OPA/ZBA policy recommendations will be presented to Town Council. Staff from Zuzek Inc. and Stantec Consulting Ltd. will be in attendance to answer questions.

Post-Engagement Objectives:

DELIVERABLES:

- Updated information for online/website platform
- Notification letter to residents/landowners.
- Flood Task Force Meeting #3
- Open house feedback forms
- PIC #3 summary report.
- Council presentation #3

PUBLIC INFORMATION CENTRES (OPEN HOUSE) RESPONSIBILITIES

	Project Team Tasks	Consultant Team	Town of Lakeshore
1.	Book Venue		√
2.	Catering		√
3.	Arrange for Road Signage, if needed		√
4.	Update PlaceSpeak project page	√	√
5.	Update Town Website		√
6.	Draft Notification/Invite	√	

7.	Mailout Notification/Invite			√
8.	Draft Social Media Advertisements			√
9.	Contact Key Stakeholders	√		
10.	Contact Businesses	√		
11.	Contact Councillor			√
12.	Sign-In Sheets and Misc. Materials	√		
13.	Feedback Forms/Comment Cards	√		
14.	Illustrations/Poster Boards/Presentation	√		
15.	Additional Information Packages			√
16.	Engagement Summary of Events	√		

PIC RULES OF ENGAGEMENT

The outcomes of the project at hand are unknown, however have t ability to generate emotional reactions from landowners and the general public. Therefore, the tone of communication will be positive, informative, and will use plain language with an emphasis on envisioning long-term solutions for the Town of Lakeshore as a whole. The communication plan and public engagement approach consists of three components:

- **Informing stakeholders and the public** about the project and its progress.
- **Engaging stakeholders and the public** at various points into help discuss and advise landowners of findings and next steps.
- **Educating stakeholders and the public** about potential outcomes of the project such as development impacts, additional regulations, or barriers to development.

Generally, the following "**PIC Rules of Engagement**" will be communicated to the project team and stakeholders where multiple opinions may be expressed:

1. He hard on issues, but easy on people.
2. Be present – avoid using phones or being distracted.
3. Actively listen –fully engage in the conversation and do not ignore anyone.
4. Be constructive, solution-oriented and seek mutually beneficial ideas.
5. Respect everyone's time.
6. Provide the opportunity for everyone to speak.
7. Be courteous and do not speak over someone - have one conversation at a time.

PIC DOCUMENTATION

After each round of PIC events in each phase, a PIC Summary will be created to document the process and feedback received. The summary will include the time, location and number of attendees at the public events (feedback and response), the results of the completed evaluation forms (how to improve the next phase of engagement), and correspondence received (e.g. phone calls, letters, emails). The consultation summary will be used to inform the Project Team and to update Council on what was heard and how the

Project Team had responded or resolved issues. The Engagement Summary is an important tool to monitor and ensure that community input is reflected in the project process.

FAQS, ENGAGEMENT RISKS, AND KEY MESSAGING

This communication plan identifies opportunities for landowners and the general public to participate in the process and to receive information that may be highly technical or challenge the status quo. General or specific concerns may arise that will need to be strategically communicated.

Consultation Fatigue - There is a danger of asking residents similar questions to those they have already been asked and therefore appearing to ignore previous feedback that was received in previous consultations.

Response: Shoreline management and floodplain mapping is a popular topic and may seem to be constantly discussed and in politics and elsewhere. Wherever possible, PIC events will be targeted at specific phase of the project and will be used to deliver targeted messages to solicit specific feedback in such a manner that is not too generic or overlap with previous phases.

Stakeholder Apathy - There is concern that the public might not understand how the shoreline management plan directly applies to them or their landholdings and view the process as a “waste of tax-payer money”.

Response: One of the key components of this Communication Plan will be to educate the public on how the shoreline management will be used as a tool to better understand the existing conditions as well as mitigate any future conflicts. To ensure that the new plan reflects public and stakeholder expectations, the engagement strategy considers perspectives from all that are affected by the change. An educational component including messaging will inform the public why the shoreline management plan is necessary, such as explaining the rationale behind the lfood modelling and how the intent is to protect public and private infrastructure as well as health and safety.

The policy is fine the way it is (no change is needed) - Another common misconception is that “if it ain’t broke, don’t fix it”.

Response: Preparing the SMP is intended to be a preventative and not a reactive approach to flooding and climate change. The SMP aims to foresee potential issues before larger, more costly, issues arise. Instituting a transparent and educational communication plan aids in mitigating this concern. All aspects need be discussed and inform a balanced conversation to identify the efforts the Town is striving for instead of focusing on only the negative aspects. For instance, increased separation/development buffers are aimed at protecting infrastructure/investment and not reducing development capability.

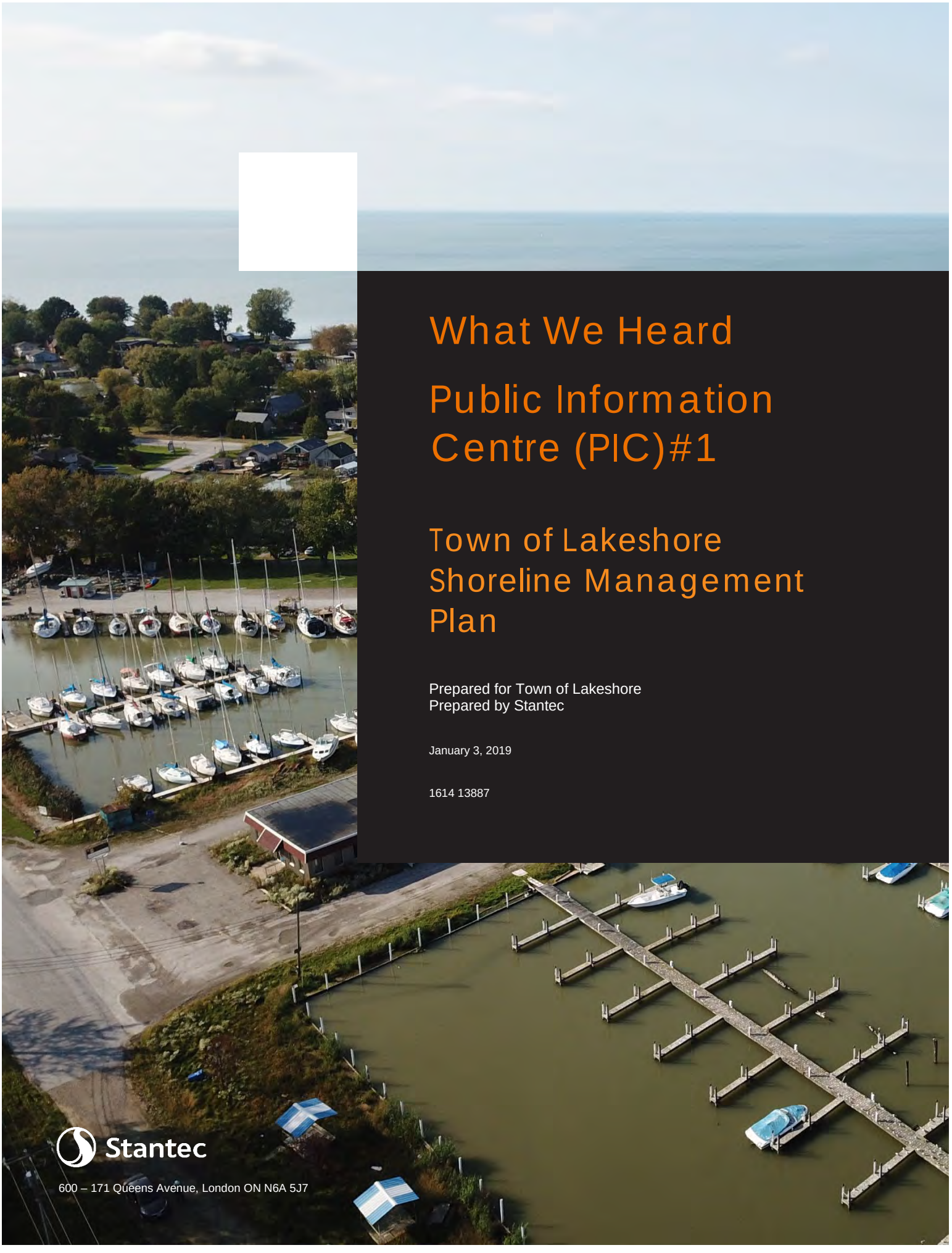
Mistrust in government/consultants – this concern stems from personal and negative experiences that would have pushed on landowners to lose confidence in their government officials or industry professionals.

Response: This concern is the most challenging issue to overcome in order to gain community buy-in. Existing mistrust may have stemmed from previous experiences or projects that had not gone too well or had poor engagement plans that "forced" the community to change that were ill-received. Gaining acceptance will be a long-term investment. This project will provide multiple opportunities to be involved as well as reporting on how feedback is used to move the project forward, which improves community ownership of the process and builds trust.

I want to build – There are many landowners that may be frustrated because the perception is that the SMP limits their permission to construct homes/buildings and is targeted toward them personally.

Response: The SMP will be derived from evidence-based scientific methodologies and will provide a set of recommendations that will help the community as a whole. Specific individual landowners or areas are not earmarked for development or non-development. The SMP reviews the entire shoreline and represents an overall scientific representation, based on existing conditions and evidence based assumptions. The SMP itself will not regulate or infringe development rights. The outcome of the SMP will become part of the overall planning framework that is implemented through policy of the Official Plan and/or the regulations of the Zoning By-law.

Appendix B Phase 1, Phase 2 & Phase 3 "What We Heard" Reports



What We Heard

Public Information Centre (PIC)#1

Town of Lakeshore Shoreline Management Plan

Prepared for Town of Lakeshore
Prepared by Stantec

January 3, 2019

1614 13887

Stantec

600 – 171 Queens Avenue, London ON N6A 5J7

Town of Lakeshore

Shoreline Management Plan

What We Heard Report

Public Information Centre 1 – November 28, 2019

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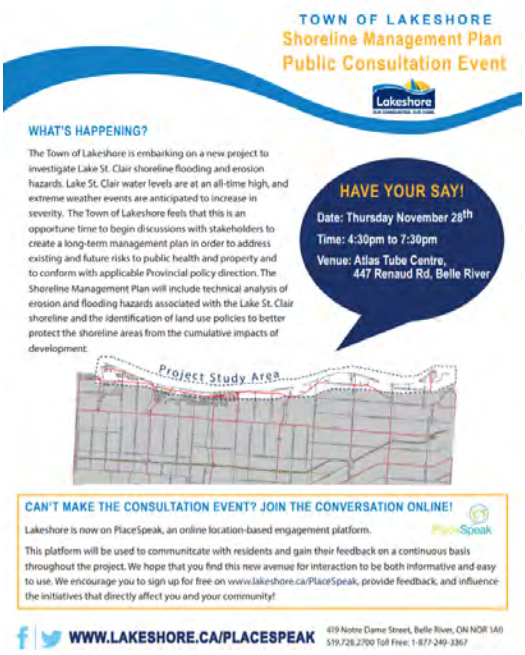
Background

The northern extent of the Town of Lakeshore consists of the Lake St. Clair shoreline and includes both serviced and unserviced development areas. Each reach of the shoreline is subject to shoreline flooding and erosion hazards.

The Essex Region Conservation Authority has been regulating development activities along the Lake St. Clair shoreline (through O. Reg. 158/06) since 1984 using flood line and erosion produced in 1976. Ongoing changes to shorelines, climate change, and continued development pressure requires the Town to update land use policies and strategies that are supported by shoreline management technical studies.

The engagement component for the project will consist of three main phases – an initial engagement with stakeholders to make introductions and identify opportunities/constraints; engagement with stakeholders and the public to review technical findings and draft policies and; and finally to present the final recommended Shoreline Management Plan (SMP) document.



Objectives

Understanding how the community interacts with shoreline areas and how they are impacted by shoreline flooding and erosion is vital to the success of the SMP. The community will be faced with issues that cross property, jurisdictional, and legislative boundaries, so we must collaborate to develop more resilient and sustainable solutions. The principles that will guide stakeholder and community engagement through the study include:

- To encourage community involvement in the planning process through transparent and accessible engagement opportunities.
- To understanding how the community perceives existing and future shoreline issues.
- To educate stakeholders on the existing and future risks and challenges, and the benefits/tradeoffs of shoreline management alternatives.
- To undertake a balanced evaluation of alternatives that reflects the priorities of all stakeholders (residents, visitors, the Town, the environment, and Indigenous communities).
- To provide clear and transparent documentation of the planning and decision-making process.

What We Did

1. Project Initiation Notice Mailout

An **Advertisement** was created and sent to community landowners to officially commence the study, provide a web address to the Town's website and new engagement software (www.lakeshore.ca/placespeak), provide contact information for key team members, and provide the event details to attend the initial Public Information Centre #1 meeting.

2. Webpage Advertising

The Town of Lakeshore's official webpage was also used to provide project status updates, Public Information Session notice details and promote the PlaceSpeak engagement platform.

3. Social Media Advertising

Several social media accounts were also used to advertise the Public Information Session. The Town of Lakeshore's social media (e.g. Twitter, Facebook) account was actively posting updates to promote the Town's new PlaceSpeak engagement platform.

4. Public Information Session:

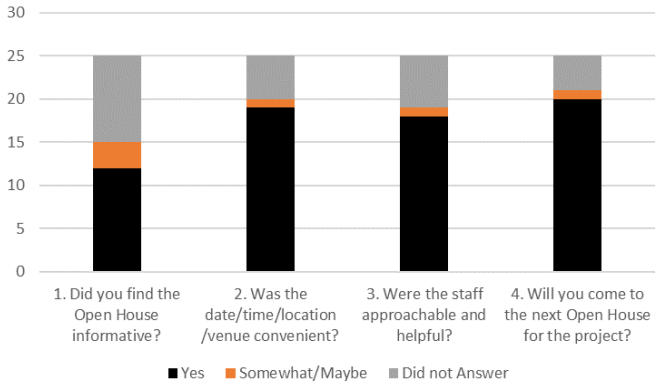
A public event was held on November 28, 2019 (4:30 - 7:30 PM) at the Atlas Tube Centre to introduce the project, project team and solicit community feedback. The intent of the initial meeting was to introduce the purpose of the Shoreline Management Plan, and identify local constraints and opportunities. In attendance, there were Town planning and engineering staff, consultants from Stantec and Zuzek Inc., and several members of Council. The Lower Thames Valley and Essex Region Conservation Authorities were also in attendance providing information to residents. There was an attendance of approximately 21 people. With the significant number of experts on-site, each person had the ability to speak with the right person and receive ample information.

What We Heard

Residents and landowners that were able to attend the event generally had a similar interest regarding shoreline protection for their property that backed onto Lake St. Clair. Residents identified the need to repair or improve their (break) walls and hoped that this study would propose to construct more significant upgrades to protect their private property. Residents were informed that the overall approach to Shoreline Management Plan will be to look at the shoreline holistically and introduce policy direction for the Town. The project will look beyond the lot-by-lot approach to develop a more cohesive plan for the shoreline areas.

Feedback

Participants that attended the Public Information Session were provided handouts that asked them to fill out and rate the experience, as well as additional survey questions. There were 25 completed feedback forms returned. The results of their rated experience were positive and illustrate the residents' overall satisfaction with the event and interest to attend another in the future.



PlaceSpeak.com

PlaceSpeak.com has been adopted by the Town of Lakeshore to be used as an online engagement tool to deliver project information and solicit poll/survey information. This is particularly useful for reaching out to residents/stakeholders that are unable to attend the public information meeting, or for those who had attended but were not able to submit feedback. Both a poll and survey were published online and made available for several weeks before and after the Information Session. The following portrays the amount of activity and results thus far.

PlaceSpeak Metrics

Website Traffic (as of January 2, 2020):

- Live for 41 days
- 158 Unique Views
- 15 Completed Polls
- 11 Completed Surveys

Participants

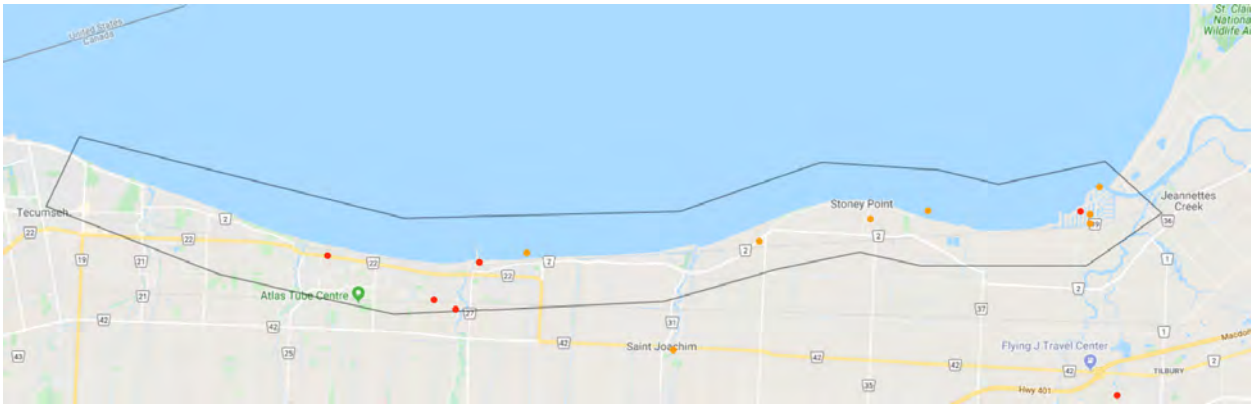
- 93 unique Followers have connected onto PlaceSpeak.
- 83% of the Followers identify as residents of Lakeshore

Poll Results

- 15 unique participants submitted poll data:

In the last 5 years, has your home or business been impacted by shoreline flooding?

The majority of participants (53%) responded “Yes”, that they have experienced and were impacted by shoreline flooding. Not surprisingly, poll participants that were impacted by flooding tended to be located nearest to Lake St. Clair. They also tended to be located in Stoney Point or Lighthouse Cove.



Survey Results

A total of 14 surveys were completed, 3 surveys were retrieved at the Public Information Centre and another 11 were filled out online using PlaceSpeak. The survey consisted of 13 open-ended questions that generally sought feedback from residents on what they perceived to be the greatest constraints, issues, concerns or challenges with managing rising lake levels, as well as identifying any opportunities they could see being implemented. The following is a summary of the received responses and comments.

Question: What is the greatest challenge facing shoreline communities in the short/long term?

“Erosion of the shoreline.” *“High water levels.”* *“Drainage.”*

““Older homes and cottages face flooding risks due to elevated water levels*.”*

“Water level fluctuation – high winds – erosion” *“Cleanliness”*

Question: What is the greatest challenge the municipality is facing with respect to the Lake St. Clair shoreline in the short/long term?

"Climate change." *"Flooding and erosion of shoreline."* *"Investments.*

"Preserving municipal properties servicing all residents (Marinas, beaches, parks, parkettes, roads)."

"Loss of sand at west beach, flooding of the Lakeview Park"

Question: With respect to flooding and erosion hazards, what are the most vulnerable areas in Lakeshore?

- *"Couture Beach and the west side of Lighthouse Cove (Melody Dr)."*
- *"Caille Ave, Lakeshore Road, all the lakefront homes."*
- *"Puce and Emeryville."*
- *"Lighthouse Cove."*
- *"Little River."*
- *"Waterfront homes and parks, low lands - places with no breakwalls."*
- *"All land on the shoreline and canal systems in Lakeshore."*

Question: What are your priorities when evaluating long term solutions to the coastal hazards in Lakeshore?

Participants were asked to rank 6 priorities when evaluating coastal shoreline recommendations. With 6 points for the highest priority and 1 point for lowest priority, the following ranked priorities were determined from highest to lowest.

Priority	Ranked Points
Implementing mitigation projects to prevent flooding.	47 Points
Ensuring safe access for emergency responders.	46 Points
Protection of private property and municipal infrastructure.	42 Points
Conservation of wildlife habitat and aquatic species.	35 Points
Annual monitoring to measure effectiveness.	31 Points
The total cost to implement recommendations.	30 Points

Question: Are there other priorities or aspects that this project should be considering?

Only few participants responded to this question. The key points taken away from their responses (below) is the desire for a review of zoning and development policies and standards in proximity to shorelines, the need for an Emergency Plan or "Residents Action Plan", and that shoreline management should include discussions and partnerships with adjacent communities including the City of Windsor.

- "The Municipality has the ability to amend current building standards for waterfront homes to ensure new constructions meets flood proofing criteria. Halting all waterfront development is a short sighted and a fiscally irresponsible approach."
- "Implementation of evacuation plan in the event of flooding"

- “Urge Windsor to work with you.”

Question: What do you think could have aided or protected your home or business from flooding?

Maintenance & Operation of Drainage Channels:

“Clean drainage flow.” *“Lower water levels, better drainage.”*

Emergency Preparedness Plans:

“Sand bagging was the only option and it worked.” *“Having pumps operational.”*

Improved or Enhanced Breakwalls*:*

“Adding more rocks to our breakwall or to have the rocks moved from out of the water into a wider wall of stone.”

Question: Are there any final comments?

“Waterfront living comes with inherent risks. Caveat Emptor [buyer beward] *principles need to be applied when issuing building permits. Homeowners could be required to review documents listing the risks associated with waterfront living and sign off on these risks . It is not the Municipalities responsibility to foresee and prevent every potential risk such as flooding.”*

“Spending money on docks and recreational issues should come after flooding and erosion issues are handled.”

“Will the water go back down? Isn't it a cycle of high water and then low water years? “

Next Steps

A second PIC is scheduled for Phase 2, in the summer of 2020, once a technical review is completed and draft options and policies can be shared. The information and input from Phase I will be:

- Used to inform and shape recommendations for land use policies and potentially make recommendations for infrastructure improvements, where needed.
- Results from Phase 1 and Phase 2 public engagement will be used to the draft Shoreline Management Plan, which will be presented to Council in the fall of 2020.

Design with
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What We Heard

Lakeshore Shoreline Management Plan
Phase 2 Consultation Summary

Date: May 11, 2021

Stantec

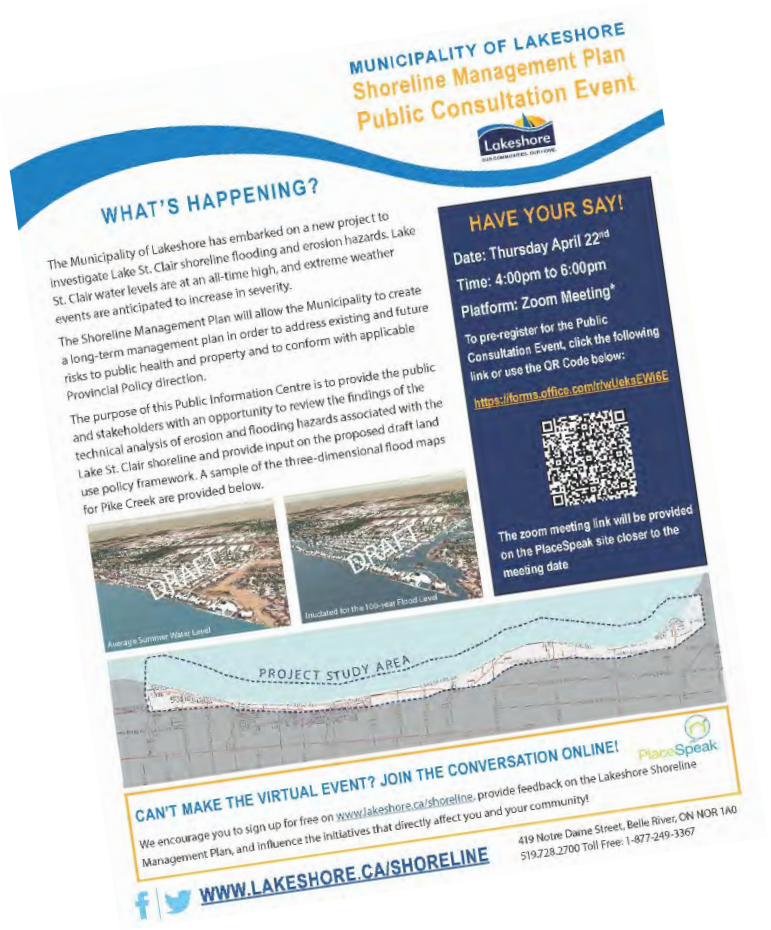
Zuzek inc.
ONE WORLD

Table of Contents

Background

The northern extent of the Municipality of Lakeshore consists of the Lake St. Clair shoreline and includes both serviced and unserviced development areas. Each reach of the shoreline is subject to shoreline flooding and erosion hazards.

The Essex Region Conservation Authority has been regulating development activities along the Lake St. Clair shoreline (through O. Reg. 158/06) since 1984 using flood line and erosion produced in 1976. Ongoing changes to shorelines, climate change, and continued development pressure requires the Municipality to update land use policies and strategies that are supported by shoreline management technical studies.



The engagement component for the project will consist of three main phases – an initial engagement with stakeholders to make introductions and identify opportunities/constraints; engagement with stakeholders and the public to review technical findings and; finally, to present the final recommended Shoreline Management Plan (SMP) document which is expected in the summer of 2021.

Objectives

Understanding how the community interacts with shoreline areas and how they are impacted by shoreline flooding and erosion is vital to the success of the SMP. The community will be faced with issues that cross property, jurisdictional, and legislative boundaries, so we must collaborate to develop more resilient and sustainable solutions. The principles that will guide stakeholder and community engagement through the study include:

- To encourage community involvement in the planning process through transparent and accessible engagement opportunities.
- To understanding how the community perceives existing and future shoreline issues.
- To educate stakeholders on the existing and future risks and challenges, and the benefits/tradeoffs of shoreline management alternatives.
- To undertake a balanced evaluation of alternatives that reflects the priorities of all stakeholders (residents, visitors, the Municipality, the environment, and Indigenous communities).
- To provide clear and transparent documentation of the planning and decision-making process.

What We Did

1. Project Initiation Notice Mailout

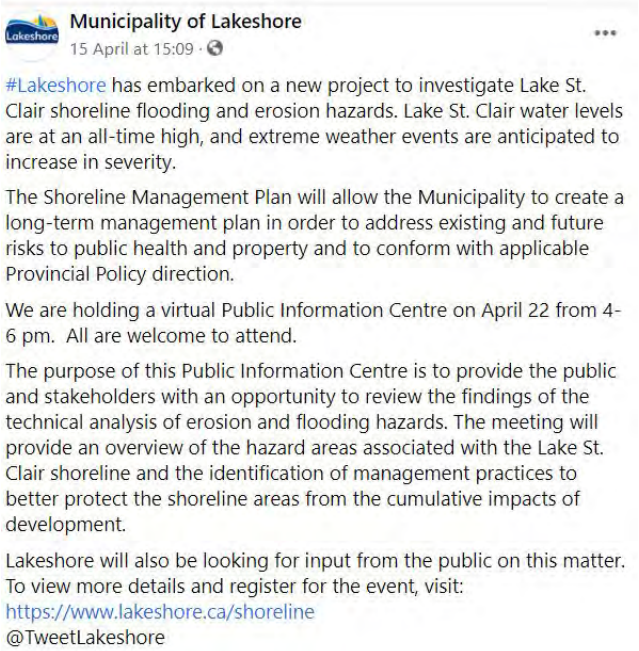
An **Advertisement** was created in the first phase of this project and sent to community landowners to officially commence the study, provide a web address to the Town's website and new engagement software (www.lakeshore.ca/placespeak), provide contact information for key team members.

2. Webpage Advertising

The Municipality of Lakeshore's official webpage was also used to provide project status updates and calendar information regarding the second Public Information Session that was held virtually on April 22, 2021, including the Zoom login details. Details and links to the PlaceSpeak engagement platform were also accessible from the Municipality of Lakeshore's main page.

3. Social Media Advertising

Several social media accounts were also used to advertise the Phase 2 Public Information Session. The Municipality of Lakeshore's social media (e.g. Twitter, Facebook) account was actively posting updates to promote Lakeshore's PlaceSpeak engagement platform, which was concurrently being updated with information.



4. Public Information Session

A virtual public event was held on April 22, 2021 (4 to 6pm) over a Zoom online platform, which is has been the typical alternative to public meetings over the course of the Covid-19 pandemic. The event provided an overview of the technical findings of the project, provided updated to the project team and solicited community feedback on directions for the Plan. The intent of this second PIC meeting was to outline the findings to date and discuss potential recommendations for the Plan's drafting which is to take place in Phase 3 of the project.

In attendance, there were Lakeshore's planning and engineering staff, consultants from Stantec and Zuzek Inc., and several members of Council and members of the community. There was an attendance of approximately 22 people. With the significant number of experts on the call, each person had the ability to ask questions about the technical review and resulting data and information.

5. Technical Findings Webpage

A summary of the technical findings to date have been consolidated in a virtual platform available at:

https://sway.office.com/YjN7QSkKOFbmPwTh

The webpage was developed using an app from Microsoft Office called "Sway" that allows for the easy creation and sharing of interactive reports, presentations and more – combining media and text to create a presentable and shareable website. This was created in lieu of a typical in-person poster presentation that would have been set-up if the event were to take place as initially planned at the outset of this project.

To date, the website has had 58 views. These views were comprised of 35 glances, 9 quick reads, 14 deep reads, according to the Microsoft monitoring tool. The webpage contains the following information and material:

- Easily scrollable Hazard Maps of the Lakeshore Shoreline, organized from 1 to 35, including the depths of the flooding hazard;
- The April 22, 2021, presentation slides presented as a 5 ½ minute video;
- Descriptions of the types of shoreline hazards that are presented on the technical mapping ("Hazard Maps");
- An explanation of how the risks and considerations of climate change were incorporate into the delineation of the Hazard Maps for the shoreline;
- Visual renderings of three (3) sites along the shoreline showing average summer levels with increases flood risks due to the lake level rise anticipated due to climate change. The sites selected were: Pike Creek, Puce, and Belle River;
- The land use policy framework for planning development along shorelines and within areas of natural hazard concern;
- The objectives of the Shoreline Management Plan and typical adaptation responses to consider;
- Descriptions of other related projects of the Municipality of Lakeshore;

- A link to provide feedback on the discussion questions that were presented in the PIC #2 and summarized in the following Section.

What We Heard

Residents and landowners that were able to attend the event generally had a similar interest regarding shoreline protection for their property that backed onto Lake St. Clair. Residents identified the need to repair or improve their (break) walls and hoped that this study would propose to construct more significant upgrades to protect their private property. Residents were informed that the overall approach to Shoreline Management Plan will be to look at the shoreline holistically and introduce policy direction for the Municipality. The project will look beyond the lot-by-lot approach to develop a more cohesive plan for the shoreline areas.

Feedback

Participants that attended the Public Information Session were provided a link to a survey which would allow them to provide longform answers to questions and rate the experience. No feedback forms were completed/submitted. The results are therefore inconclusive.

General Questions & Answers

Residents and landowners who attended this PIC were given the opportunity to ask specific questions during General Question and Answer breaks during the meeting. Questions below are from the participants and answers were provided by either Stantec Consulting representatives, Zuzek Consulting representatives, or municipal staff.

Questions and Answers:

Q: *Water levels have been high in previous decades. How is this work different from what was used then? How were the levels in this Management Plan determined and how was the climate change amount determined?*

- A: *Water levels have been generally higher the last couple years and climate change is expected to make things worse. We need to consider how we can plan better to keep the health of the community and maintain access. Environment Canada had a very comprehensive study completed using a range of climate experts to come up with their results.* – Zuzek Consulting Representative

Q: *Are the simulations shown in the presentation available for all areas of Lakeshore or only the 3 locations shown?*

- A: *The locations were selected in coordination within the municipality where risks were high. Resources were available to produce these three locations but other locations have not been done.* – Zuzek Consulting Representative

Q: *The conceptual maps illustrating the extent of flooding indicates that there is are potential impacts not only to residential property and the Town's infrastructure, but also a threat of*

structural floor damage to railway infrastructure. Has the rail company participated in any of the discussions to date?

- A: *Via Rail hasn't been consulted yet but will likely be made aware now that we have the information available to share.* – Stantec Consulting Representative & Municipal Staff

Q: *The Sanitary/Stormwater system has been overwhelmed when lave levels are high. What will be done to avoid this in future?*

- A: *Yes, the high lake levels are expected to impact these systems as well as road access. A range of recommendations for storm system improvements are provided in the Stormwater Master Plan which can help address these vulnerabilities.* – Stantec Consulting Representative

Q: *Can you share your recommendations with us?*

- A: *Recommendations will be part of Phase 3 of the work and will be presented at the 3rd PIC.* – Stantec Consulting Representative

Q: *Your planned schedule looks pretty aggressive. Do you feel confident you can meet these deadlines?*

- A: *We plan to get this project to council in a timely fashion in order to meet the deadlines.* – Stantec Consulting Representative

Q: *What is going to be in the scope in terms of recommendations for individual property solutions to this issue? Can you elaborate on solutions being considered within the study for effective action?* – Zuzek Consulting Representative

- A: *There will likely be recommendations for things you can do on your property, for example upgrading sea wall. Solutions presented may be more general in nature. Recommendations won't include specific solutions with detailed drawings, etc.* – Zuzek Consulting Representative

Q: *Is there a plan to address the conversion of residential septic tanks to septic sewers?*

- A: *That could be a consideration, for example, in Lighthouse Cove where the Municipality is looking at putting in a municipal sanitary system. We will take the mapping information that has been prepared and incorporate it into the planning bylaw. We would, however, still require an engineer to look at how this impacts new development.* – Municipal Staff

Q: *There are probably a lot of things homeowners in the area could do to our homes to protect them better. Would it be possible for someone from the Town to consult with waterfront/flood risk landowners on what they can do better? Is it possible to provide a list of recommended partners or companies that landowners could work with?*

- A: *The SWMP has some recommendations which could be helpful. The height of sea walls has been previously mentioned as someone homeowners can improve to protect their property. We're unsure at this time if a recommended list of companies to address impacts would be available.* – Stantec Consulting Representative, Zuzek Consulting Representative, Municipal Staff

Discussion: Questions & Answers

Adaptation Strategies:

What option do you feel is the most appropriate long-term mitigation strategy to reduce flood risk and increase resilience?

Did any of the strategies presented introduce a concept that you strongly disagree with? If so, why?

- *"Should do portions of all four options"*
- *"Full Retreat option not feasible"*
- *"Are there interim solutions other than Sandbags?*

Past Experience:

What is your experience with flooding in the past? (e.g. loss of land, basement floods, insurance impacts, etc.). How severe has your experiences with flooding been? (e.g. minor nuisance vs. major damage to property)

- No response – Participants encouraged to fill out response on the provided form.

Scale of Solutions:

Would you be interested in participating in a community scale flood mitigation concept (versus every landowner doing something different)?

What scale do you think is most appropriate to address these challenges?

Would you support management approaches that rely on financial contributions from private landowners and other sources?

- *"Watershed approach would be best"*
- *"Everybody has to do the same thing"*
- *"Neighbourhood has to be on the same page"*
- *"Solutions are potentially very expensive"*
- A: *The intent is to prepare a plan for when funds become available (ie. Federal funding opportunities) to help mitigate costs. – Stantec Representative*
- A: *Traditionally, private owners have had responsibility for their own seawalls. It will need to be determined if there are incentives/funding to support solutions implemented by the municipality. We're hopeful the study will help with pursuing funding options. – Municipal Staff*

Climate Change Risk:

Should the community be taking steps now to adapt to future flood risks associated with climate change?

- *"Yes, steps we can take are limitless if there is a lot of provincial and federal funding"*
- *"Yes, Municipality will need to advocate for funding"*

- *"Yes, but concerned about the financial burden for homeowners"*
- *"Yes, but don't want the Municipality to get into the business of lending money to private owners"*
- *"Yes, and prefer use of hard and soft engineering practices"*
- *"Yes, we should be building in resiliency and minimizing peak flows"*

? Q: *"Could we explore the option of putting barriers offshore to help break waves before the wall?"*

- A: *Offshore barriers is a strategy being used in Canada and internationally. The concept is worth looking into, but will have to consider how this impacts recreational boating as a hazard. The most likely solution will be close to seawalls themselves using a sloping face so that the waves don't crash as high as they would along a vertical wall.* – Zuzek Consulting Representative

? Q: *Are natural approaches applicable? Does this include rocks?*

- A: *Traditional approaches include the use of rocks, concrete, and steel. Hybrid solutions that incorporate natural elements are becoming more popular. Other ideas would be to slope beaches to deflect wave energy, and incorporating vegetation. A White Paper about how we can do more with natural solutions has been created. Options that improve ecosystems and natural environments will help when pursuing funding. Hybrid Solutions may be well suited for this project.* – Zuzek Consulting Representative

? Q: *Any thoughts about restoring our wetlands and floodplains?*

- A: *These are the types of projects that can be included when taking steps to reduce flood risks etc. Federal funding would likely go to solutions that also benefit habitats.* – Zuzek Consulting Representative

Next Steps

A third PIC is scheduled for Phase 3, in the summer of 2021, once a draft shoreline management plan and its associated recommendations are completed and the final suggested options and policies can be shared. The information and input from Phase 2 will be:

- Used to inform and shape recommendations for land use policies and potentially make recommendations for infrastructure improvements, where needed.
- Results from Phase 1 and Phase 2 public engagement will be used to the draft Shoreline Management Plan, which will be presented to Council after the public has had an opportunity to review and comment on the draft recommendations.

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Town of Lakeshore

Shoreline Management Plan

What We Heard Report

Public Information Centre 3 (Virtual)

February 22, 2022

Table of Contents

Background

The northern extent of the Municipality of Lakeshore consists of the Lake St. Clair shoreline and includes both serviced and unserviced development areas. Each reach of the shoreline is subject to shoreline flooding and erosion hazards.

The Essex Region Conservation Authority and the Lower Thames Conservation Authority have been regulating development activities along the Lake St. Clair shoreline (through O. Reg. 158/06) since 1984 using flood line produced in 1976. Ongoing changes to shorelines, climate change, and continued development pressure requires the Municipality to update land use policies and strategies that are supported by shoreline management technical studies and updates mapping.

The engagement component for the project consisted of three main phases – an initial engagement with stakeholders to make introductions and identify opportunities/constraints; engagement with stakeholders and the public to review technical findings and; finally, to present the final recommended Shoreline Management Plan (SMP) document which is expected in March of 2022.

Objectives

Understanding how the community interacts with shoreline areas and how they are impacted by shoreline flooding and erosion is vital to the success of the SMP. The community will be faced with issues that cross property, jurisdictional, and legislative boundaries, so we must collaborate to develop more resilient and sustainable solutions. The approach that guided stakeholder and community engagement through the study include:

- To encourage community involvement in the planning process through transparent and accessible engagement opportunities.
- To understanding how the community perceives existing and future shoreline issues.
- To educate stakeholders on the existing and future risks and challenges, and the benefits/tradeoffs of shoreline management alternatives.
- To undertake a balanced evaluation of alternatives that reflects the priorities of all stakeholders (residents, visitors, the Municipality, the environment, and Indigenous communities).
- To provide clear and transparent documentation of the planning and decision-making process.

What We Did

1. PIC #3 Notice

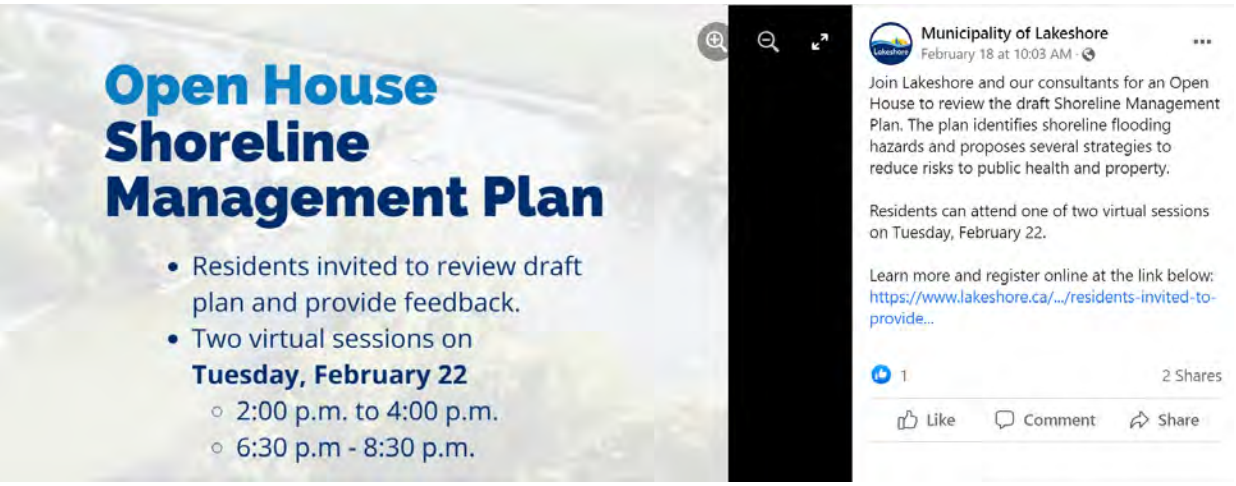
A **Notice** was created in the third phase of this project and sent to community landowners to make landowners aware of the planned, final PIC event. The Notice included background information about the project, log-in details for the event, as well as contact information for the project team. The Notice was sent out to the project stakeholder list via email and was also posted to the project PlaceSpeak page.

2. Webpage Advertising

The Municipality of Lakeshore's official webpage was also used to provide project status updates and calendar information regarding the third and final Public Information Session that was held virtually on February 22, 2022, including a sign-up form to request to receive the Microsoft Teams login details. Details and links to the PlaceSpeak engagement platform were also accessible from the Municipality of Lakeshore's main page.

3. Social Media Advertising

Several social media accounts were also used to advertise the Phase 3 Public Information Session. The Municipality of Lakeshore's social media (e.g. Twitter, Facebook) account was actively posting updates to promote Lakeshore's PlaceSpeak engagement platform, which was concurrently being updated with information.



4. Public Information Session

Two virtual public events were held on February 22, 2022 (2 to 4pm and 6:30 to 8:30pm) over the Microsoft Teams online platform, which has been the typical alternative to public meetings over the course of the Covid-19 pandemic. The purpose of the third and final Public Information Centre was to provide the public and stakeholders with an opportunity to review and provide input on the draft, complete

shoreline management plan, which contains shoreline improvement recommendations for the short and long term.

In attendance, there were Lakeshore's planning staff, consultants from Stantec and Zuzek Inc., several members of Council and members of the community. In total, attendance at the events was as follows:

- Afternoon session: 11 attendees (15 pre-registrations)
- Evening session: 5 attendees (5 pre-registrations)

With the significant number of experts on the call, each person had the ability to ask questions about the technical review and resulting data and information.

5. Technical Findings Webpage

A summary of the technical findings to date have been consolidated in a virtual platform available at:

https://sway.office.com/YjN7QSkKOFbmPwTh

The webpage was developed using an app from Microsoft Office called "Sway" that allows for the easy creation and sharing of interactive reports, presentations and more – combining media and text to create a presentable and shareable website. This was created in lieu of a typical in-person poster presentation that would have been set-up if the event were to take place as initially planned at the outset of this project.

To date, the website has had 244 views. These views were comprised of 174 glances, 38 quick reads, and 32 deep reads, according to the Microsoft monitoring tool. The webpage contains the following information and material:

- A fly-over video of the Municipality of Lakeshore, illustrating the 1:100 year flood hazard limit for the shoreline;
- The February 22, 2022, presentation slides presented as a 3 ½ minute video;
- A summary of the Shoreline Management Plan Recommendations, by Reach Area;
- A Summary of what a Shoreline Management Plan does and can achieve;
- Descriptions of the types of shoreline hazards that are presented on the technical mapping ("Hazard Maps");
- An explanation of how the risks and considerations of climate change were incorporate into the technical analysis and findings of the report;
- Visual renderings of three (3) sites along the shoreline showing average summer level, the 100-year lake level, and the 100-year climate change lake level. The sites selected were: Pike Creek, Puce, and Belle River;
- The land use policy framework for planning development along shorelines and within areas of natural hazard concern;

- The objectives of the Shoreline Management Plan and typical adaptation responses to consider;
- Descriptions of other related projects of the Municipality of Lakeshore;
- A link to provide feedback on the discussion questions that were presented in the PIC #2 and summarized in the following Section.

What We Heard

Residents were informed that the overall approach to Shoreline Management Plan is to look at the shoreline holistically and introduce policy direction for the entire Municipality. The project looks beyond the lot-by-lot approach to develop a more cohesive plan for the shoreline areas.

Feedback

Polls were posed within each PIC session to obtain live feedback from attendees. Participants that attended the Public Information Session were also provided a link to a survey which allowed them to provide longform answers to questions and rate the experience. This survey was also shared with the project stakeholders list. The results are provided in the following subsections.

Poll Responses

Polls, the Microsoft Teams Tool, was utilized during each PIC session. The poll responses were posted throughout each PIC session to obtain live feedback from attendees and to keep attendees engaged during each virtual event. Six (6) polls were asked in total for each session and the responses overall are as follows:

- Almost 40% of attendees at the PIC sessions have had their home or business impacted by shoreline flooding in the last 5 years.
- 19 % of attendees are very concerned about emergency vehicle access in Lakeshore during a coastal flood. 37% are somewhat concerned, and 26% are not very concerned.
- 40% of attendees were surprised by the extent of flooding shown on any of the visualizations and/or mapping shown as part of the presentation. 41% were not.
- 88% of attendees believe that the Municipality of Lakeshore should complete further local-scale studies to evaluate limitations with their emergency vehicle fleet (fire, ambulance, police) during a coastal flood and develop appropriate adaptation/contingency plans to improve emergency access.
- 82% of attendees advised that they would support stronger development controls in Lakeshore so future buildings and infrastructure are located away from areas impacted by natural hazards.
- 88% of attendees believe that the Municipality and landowners should collaborate on future reach-specific studies to develop guidelines for shoreline protection upgrades and implement a minimum standard of protection for every property along the lake and rivers.

Survey Responses

Two survey responses were received in total following the third PIC. The responses received were very contrasting and therefore lead to inconclusive results. The general questions and answers, as well as the poll results were more conclusive. Feedback received from the surveys included the following:

What are your initial thoughts about the recommendations of the report?

- I hope to get a copy of the report. I was late to the meeting.
- I have owned property in Lighthouse Shores since the canal development was completed in 1969. My property is on Quenneville. Both Quenneville & Duplessis have never had roads but have formal lot plans submitted and are considered development vs infill on the other 6 roads in this canal community. A secondary plan to consider this area was not discussed. As a result, your recommendations provide limited creative solutions to capturing the value to the community that developing this area can provide. Practical flood mitigation alternatives were given limited discussion. The crisis approach to panic owners, community or municipality does not provide an inclusive, participative approach to addressing each of these lake shore impacted areas.

Are there any recommendations missing, or anything you feel should be more thoroughly considered as the municipality finalizes the report's recommendations?

- Yes, include properties on the adjacent side of road from the lakefront properties.
- Your recommendations are short sighted and do not provide sufficient consideration for building in this area and does not consider that substantial investment in the area has already been made and tax revenue from this area could be substantial if developed. More substantial mitigation steps should be established to recognize the value of the existing and potential community enhancement.

Are there any recommendations that you feel should be deleted?

- Not that I can see.
- Freezing development should be a very last option or be eliminated. It does not appear as though we are close to that.

Did any of the strategies presented introduce a concept that you strongly disagree with? If so, why?

- I missed the first portion of the meeting but I hope that all of Lakeshore development is under the same microscope as their waters are diverted to the shoreline via concrete and asphalt.
- Freezing development should be a very last option. It has been presented as a close term priority and without considering the impact to growth, increased density or responsible development. Emphasis absolutely needs to be RESPONSIBLE DEVELOPMENT moving forward.

What is your past experience with flooding? (e.g. loss of land, basement flooding, insurance impacts, etc.)

- Storm water surges have caused issues and we are concerned. Rain causes many sleepless nights between monitoring pumps, drainage, sandbagging and shore wall.

- I have owned property on Quenneville Drive since 1969 and have seen water levels change as much as 3 feet this year alone. Yes, water levels have breeched older break walls but have since receded. Lake surge is also an issue. New enhancements & additional mitigation need more emphasis in this proposal. I haven't had my lots on Quenneville resurveyed to determine the impact to my waterline but my property has remained above water.

Would you be interested in participating in a community-scale flood mitigation concept (versus every landowner doing something different)?

- I don't believe this will happen. We have been asking for this for a while and we have spent money to secure our area already while others have done nothing.

- I am interested in considering all mitigation strategies.

Would you support management approaches that rely on financial contributions from you and a collection of neighbours? For instance, through a local improvement charge associated with your municipal taxes.

- If that is the way to get this resolved. It should be investigated that the development of new properties with excessive amounts of concrete and asphalt are not responsibly maintaining their own water. These new property developments are also the ones that have basements.

- I would consider it if I am also granted the opportunity to have building permits. Infrastructure in Lighthouse Shores must be brought to standard in advance including roads for Duplessis & Quenneville before I would be in support of contributing to such a fund.

Should the community be taking steps now to adapt to future flood risks associated with climate change?

- Yes as the storm water is not being adequately controlled. It feels like long term residents are the ones saddled with the responsibility. It appears to me that the "turn over" of ownership in the new property developments has been very high.

- The community should be involved in establishing near and long term strategies to adapt to flood risks so that short term funding does not become redundant, wasted resource as longer term strategies are implemented

General Questions & Answers

Residents and landowners who attended this PIC were given the opportunity to ask specific questions during General Question and Answer session during the meetings. Questions below are from the participants and answers were provided by either Stantec Consulting representatives, Zuzek Inc. representatives, or municipal staff.

Questions and Answers:

Q: Do you also utilize data from the US Marine Army Corp. regarding ice coverage of the great lakes?

A: Ice cover data from the Great Lakes Environmental Research Laboratory, part of the USA Federal Government, is used regularly.

Q: Does the climate model include rainfall of the Great Lakes Basin? And, has Canadian Pacific Rail (CPR) been consulted, as it is clear the CPR Line is not holding the water that it was thought to.

A: Yes, CPR and members of their consultant team have been consulted. Additionally, Environmental and Climate Canada simulates the processes that impact lake levels (rainfall, snow, snow melt, evaporation over the lakes, and evaportranspiration over the land). Science is not suggesting the lakes will only be high – is saying that there will still be high and low periods but the extremes will be more extreme.

Q: Can you confirm if the video shown of the shoreline is the joint 1:100 year urban rainfall based flood and coastal flood at the same time?

A: No, the analysis and flood mapping is just the combined impact of the high lake levels and storm surges, it is not assuming rain. The analysis did not include rainfall inputs.

Q: Will this policy address floating homes or structures being built on docks out into the lake?

A: Not sure about floating homes along the lakeshore, as they typically work where they are sheltered from wind and waves, etc. This idea was also brought up by the Conservation Authority in their comments, so we will be addressing it in the updated report. It could be a possible alternative in some instances in very sheltered areas (e.g., creeks and canals, not open lakes), where a proponent comes forward with a design that is innovative and structurally sound, and properly engineered. Consideration for ingress and egress for vehicles and emergency management during a time of flooding, would still need to be evaluated.

Municipal staff also advised that Lakeshore recently approved a zoning by-law that bans floating homes in all locations of Lakeshore (river or shoreline). If someone proposed one, they would need to apply for a zoning amendment, and it would be reviewed on a case-by-case basis.

Q: What is the timeline beyond comments being due February 24th?

A: March 15th is the council meeting date. The draft report will be provided early March to Council and posted to the website for public download on March 11th.

Q: From information received to date, will any part of the plan change drastically?

A: Nothing materially will be changed but will need to clarify 'redevelopment' so as to not confuse it with 're-building'. Certain recommendations have been requested to be expanded on, as well. Also, there is a need to be clearer to the implementation of the shoreline management plan through permitting with conservation authorities and agencies.

Q: Flood task force will get copy of the plan? Is there a problem with me sharing it with the task force?

A: No. not an issue with sharing this information, both the slides from tonight and the draft report.

Q: What are the controls to lake level and who has control?

A: There are no human controls on water levels in Lake St. Clair – only natural systems. There are no dams or other methods of control. There are only a few places in the Great Lakes (St Lawrence River and Lake Ontario) that have human controls, but these locations do not impact Lake St. Clair. It is important to work together with municipalities like Lakeshore to help communities learn to live with flooding. In summary, there is nothing we can do to change anticipated lake flooding levels

Q: Does wave activity include surge?

A: Yes.

Q: I have two old cottages on two adjoining lots in Stoney Point East (Reach 5). Both are approximately 80 years and not amenable to any modification to their current structure in order to flood-proof them. Specifically, architects have already told me that it is not feasible or economically sensible to try to raise the foundation, given their age and condition. One lot has a new ERCA approved break wall. The other is partially protected and a protective berm could be added to the existing sand beach. The only sensible solution to have a flood-proof home is to raze both cottages and build one new larger house over both lots, and build that house on a new higher foundation. Is there any part of your proposal (i.e., against "new development") that would prevent me from doing this?

A: Access to and from (emergency access) is important. This is a lot specific question and is something that would need to be discussed with the ERCA and Municipality. Access into and out of individual properties is increasingly important, as regulated by the Province, but is something that the Municipality and ERCA would have to look at in more detail.

Q: Zone 7 appears that the rail tracks are still below 100 year flood lake level. What are the alternatives there?

A: While some area is above the 100 year flood, some are not and there are also culverts and low-lying roads that go under the tracks and allow flood waters to move further inland.

Q: What about the properties on the opposite side of the road from the lake? Their plans should also be collaboratively shared with concerned properties. They have added fill to their properties

and these are pushing water to homes on the waterside of the road. There are no detention ponds or any controls developed into their plans.

A: All properties on hazardous lands go through conservation authority review to confirm compliance. Any property within the flood hazard of the specific reach, regardless of the side of the road they are on, would be subject to the recommendations of the SMP.

Q: There should be more creative solutions, not just prohibiting development.

A: Working together as a community is an innovative solution, understanding the impact that this will have on the community and coming together to create a solution is not happening in other places across the province. Not developing is really the only solution. This will also need to be combined with other approaches to help mitigate the existing flood risk.

Q: Does the Plan differentiate infill vs development activities?

A: Generally, both are being addressed at the high-level, however, no matter greenfield or infill, both are not encouraged on hazardous lands. Development in the plan refers to anything that changes the density or use of property (both existing built-up area and new).

Q: I had involvement in Detroit River Development in early 2000 and they thought the river was going to dry-up. What has changed?

A: Simulating the climate in the future is challenging. Older models of climate impact did not have a good way to model evaporation and linked evaporation loses to temperature. Older models were over-predicting the loss of water from the lakes and land. New research from Environmental and Climate Change Canada has more robust way to model evaporation losses. We are not suggesting, however, that lake levels will not continue to go through peaks and lows. New highs are going to be higher, new lows are going to be lower.

Q: It appears that the entire community of Lighthouse Cove is coloured blue. This area is currently having sewage problems. The municipality should not even consider constructing a new sewage system. It would be throwing good money after bad. Shouldn't Lighthouse Cove go under a retreat protocol instead of accommodate?

A: Both retreat and accommodate are viable strategies. The easiest part is to lay out the option. The challenging part is to implement the options as to be determined and implemented and approved by the local Lighthouse Cove community, staff, council, and the Conservation Authority.

Next Steps

This third PIC was the final PIC scheduled for the Shoreline Management Plan Project. Stantec Consulting Ltd. and Zuzek Inc. will now take the comments received to date from the public, as well as the comments received from staff, agencies, and the TAC committee, and incorporate said comments into the final Shoreline Management Plan. It is the intent of the project team to post the final document to the project website on March 11th and bring the Plan before Council for adoption on March 15th.

Appendix C Shoreline Change Maps

1975
W.L. = 175.58 m

Legend

2019 Waterline

2019

Puce River

2004
W.L. = 174.86 m

2019

2015
W.L. = 175.20 m

2019

2019
W.L. = 175.63 m

2019

KEY MAP

Site

Lakeshore

Emeryville

Belle River

Stoney Point

0 1 km

TOWN OF LAKESHORE SHORELINE MANAGEMENT PLAN

Shoreline Change at Puce River Outlet

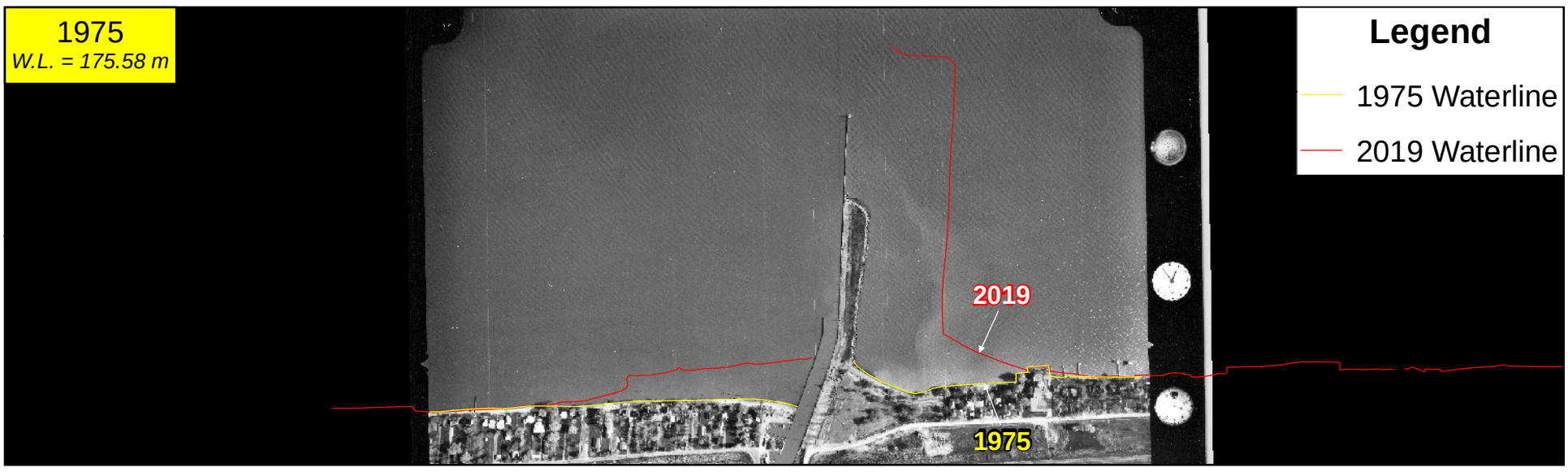
Aerial Photo Sources:
1975 - ERCA
2004, 2019 - County of Essex
2015 - ECCC

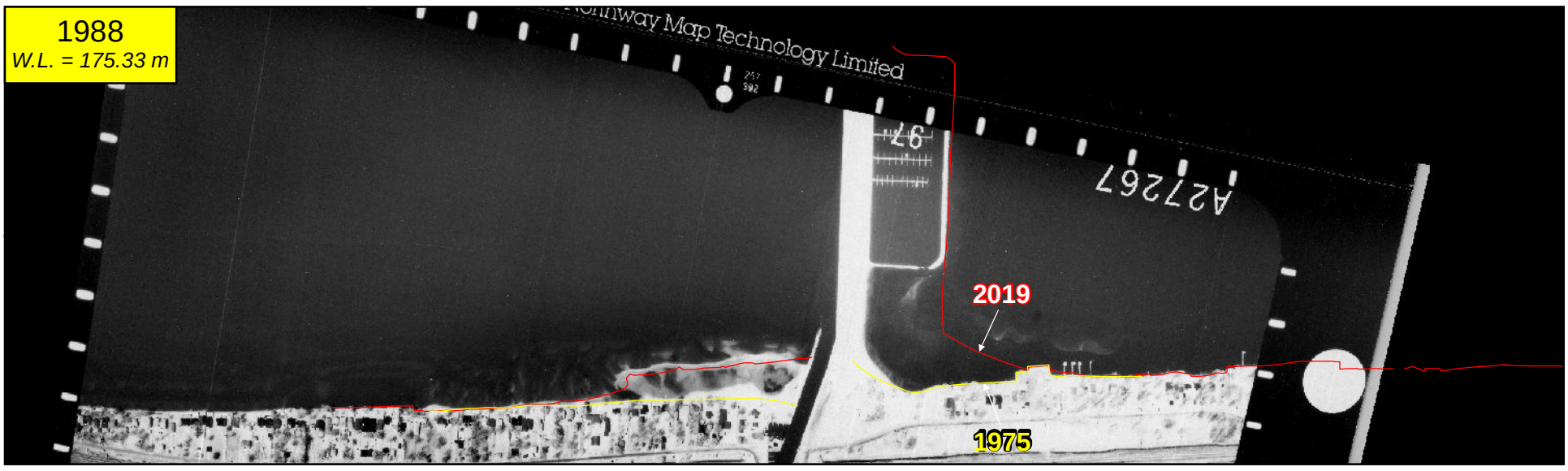
Water Levels (W.L.) referenced to IGLD'85, m.

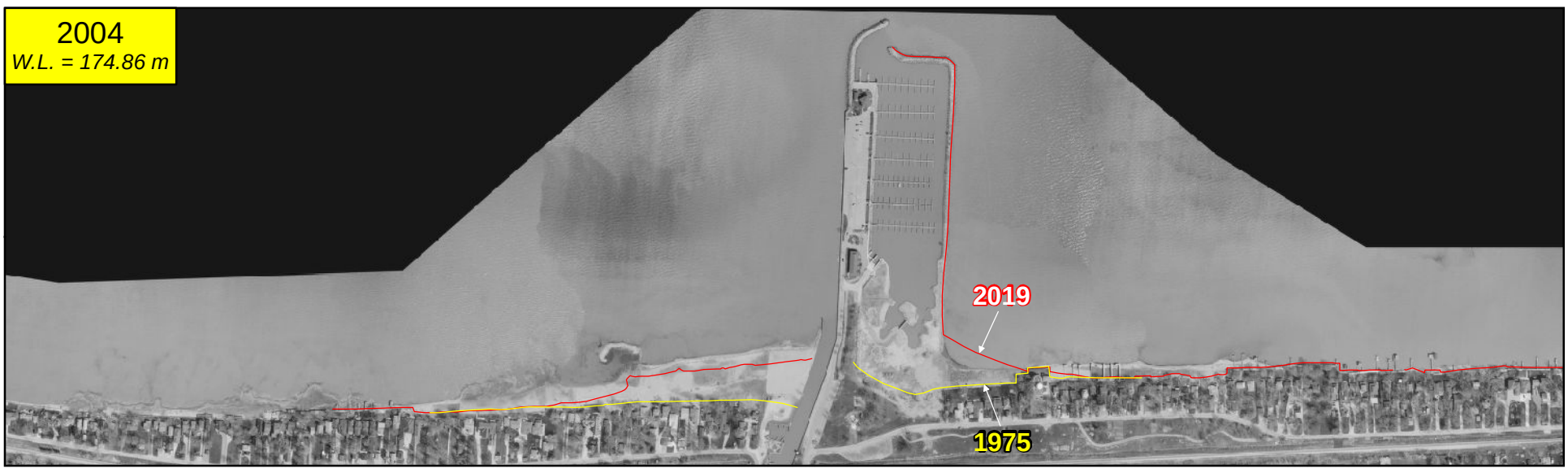
0 50 100 m

N

Zuzek inc.
ONE WORLD







TOWN OF LAKESHORE SHORELINE MANAGEMENT PLAN

Belle River Fillet Beach Evolution 1975 to 2019

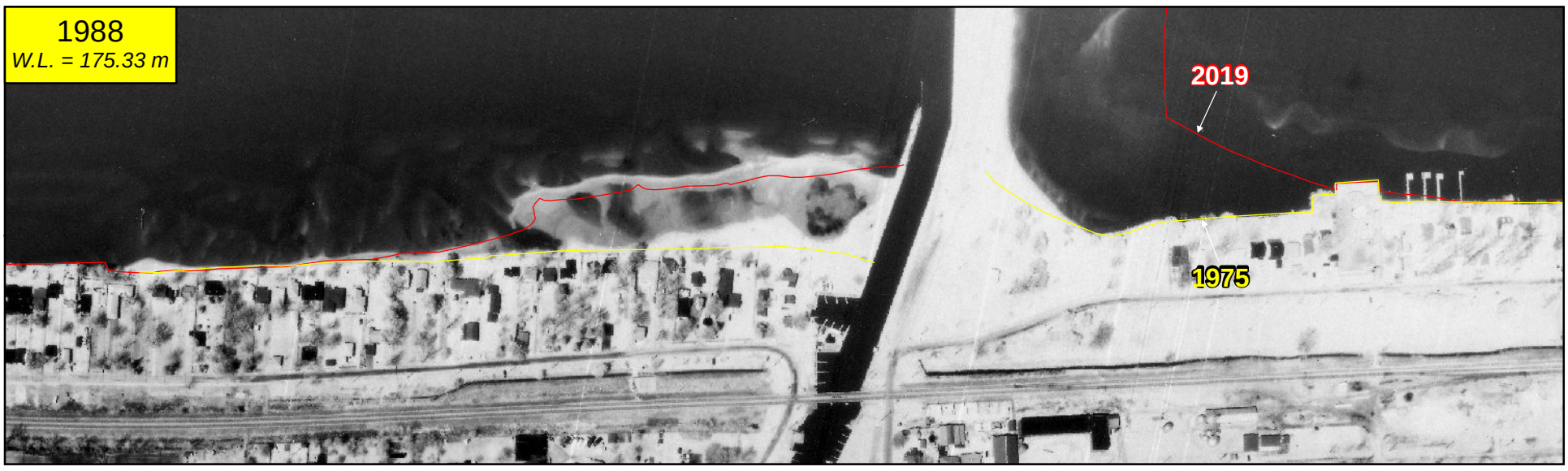
Aerial Photo Sources:
1975, 1988 - ERCA
2004, 2019 - County of Essex
2015 - ECCC

Water Levels (W.L.) referenced to IGLD'85, m.

0 50 100 150
m

N

Zuzek inc.
ONE WORLD



TOWN OF LAKESHORE
SHORELINE MANAGEMENT
PLAN

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Aerial Photo Sources:
1975, 1988 - ERCA
2004, 2019 - County of Essex
2015 - ECCC

Water Levels (W.L.) referenced to IGLD'85, m.

0 50 100
m

N

Zuzek inc.
ONE WORLD

1975
W.L. = 175.58 m

Legend

2019 Waterline

2019

Ruscom River

2004
W.L. = 174.86 m

2019

2015
W.L. = 175.20 m

2019

2019
W.L. = 175.63 m

2019

KEY MAP

Site

Lakeshore

Emeryville

Belle River

Stoney Point

0 1 km

TOWN OF LAKESHORE SHORELINE MANAGEMENT PLAN

Shoreline Change at Ruscom River Outlet

Aerial Photo Sources:
1975 - ERCA
2004, 2019 - County of Essex
2015 - ECCC

Water Levels (W.L.) referenced to IGLD'85, m.

0 50 100 m

N

Zuzek inc.
ONE WORLD

1975
W.L. = 175.58 m

Legend

1975 Waterline

1975

Little Creek

2004
W.L. = 174.86 m

1975

2015
W.L. = 175.20 m

1975

2019
W.L. = 175.63 m

1975

KEY MAP

Site

Lakeshore

Emeryville

Belle River

Stoney Point

22

2

31

0 1 km

TOWN OF LAKESHORE SHORELINE MANAGEMENT PLAN

Shoreline Change at Little Creek Outlet

Aerial Photo Sources:
1975 - ERCA
2004, 2019 - County of Essex
2015 - ECCC

Water Levels (W.L.) referenced to IGLD'85, m.

0 50 100 m

N

Zuzek inc.
ONE WORLD

1975
W.L. = 175.58 m

Legend

1975 Waterline

1975

2004
W.L. = 174.86 m

1975

2015
W.L. = 175.20 m

1975

2019
W.L. = 175.63 m

1975

KEY MAP

Site

Lakeshore
Emeryville
Belle River
Stoney Point
22
2
31
0 1 km

TOWN OF LAKESHORE SHORELINE MANAGEMENT PLAN

Shoreline Change near Lighthouse Cove

Aerial Photo Sources:
1975 - ERCA
2004, 2019 - County of Essex
2015 - ECCC

Water Levels (W.L.) referenced to IGLD'85, m.

0 50 100 m

N

Zuzek inc.
ONE WORLD

1975
W.L. = 175.58 m

Legend

2019 Waterline

2019

Thames River

2004
W.L. = 174.86 m

2019

2015
W.L. = 175.20 m

2019

2019
W.L. = 175.63 m

2019

KEY MAP

Site

Lakeshore

Emeryville

Belle River

Stoney Point

22

2

31

0 1
km

TOWN OF LAKESHORE SHORELINE MANAGEMENT PLAN	Shoreline Change at Thames River	Aerial Photo Sources: 1975 - ERCA 2004, 2019 - County of Essex 2015 - ECCC Water Levels (W.L.) referenced to IGLD'85, m.	0 50 100 m N	Zuzek inc. ONE WORLD

Appendix D Mapping of Shoreline Flood Hazards

MUNICIPALITY OF LAKESHORE HAZARD MAPS

SHORELINE MANAGEMENT PLAN

LEGEND:

- Erosion Hazard Limit
- Dynamic Beach Hazard Limit
- ERCA-LTVCA Boundary
- Municipal Boundary

100-year Flood Hazard - Depth of Flooding (m)

- 0 - 0.3 m (Up to ~1 ft)
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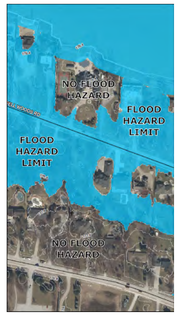

INTERPRETATION OF THE HAZARD MAPS:

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DEFINITIONS:

Depth of Flooding

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- *From Belle River to Stoney Point (Maps 13 to 25):* +176.33 m IGLD85 (+175.92 m CGVD2013)
- *From Stoney Point to Lighthouse Cove (Maps 25 to 35):* +176.57 m IGLD85 (+176.1 m CGVD2013)

Flood Hazard Limit

The Flood Hazard Limit is defined as the 100-Year Flood Level plus an allowance for wave runup and uprush. For the exposed shoreline, wave effects are calculated based on localized nearshore conditions and waves. Lake flooding in tributaries and drains estimated. Riverine floodplain not mapped. Refer to the Municipality of Lakeshore Shoreline Management Plan for additional details.

Erosion Hazard Limit

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Dynamic Beach Hazard Limit

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Inset Map: © OpenStreetMap contributors

Datums:
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Vertical: IGLD'85, metres

Datum Conversion:
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IGLD'85 and CGVD1928 are equivalent (average difference of 0 m).

0 50 100 200 m

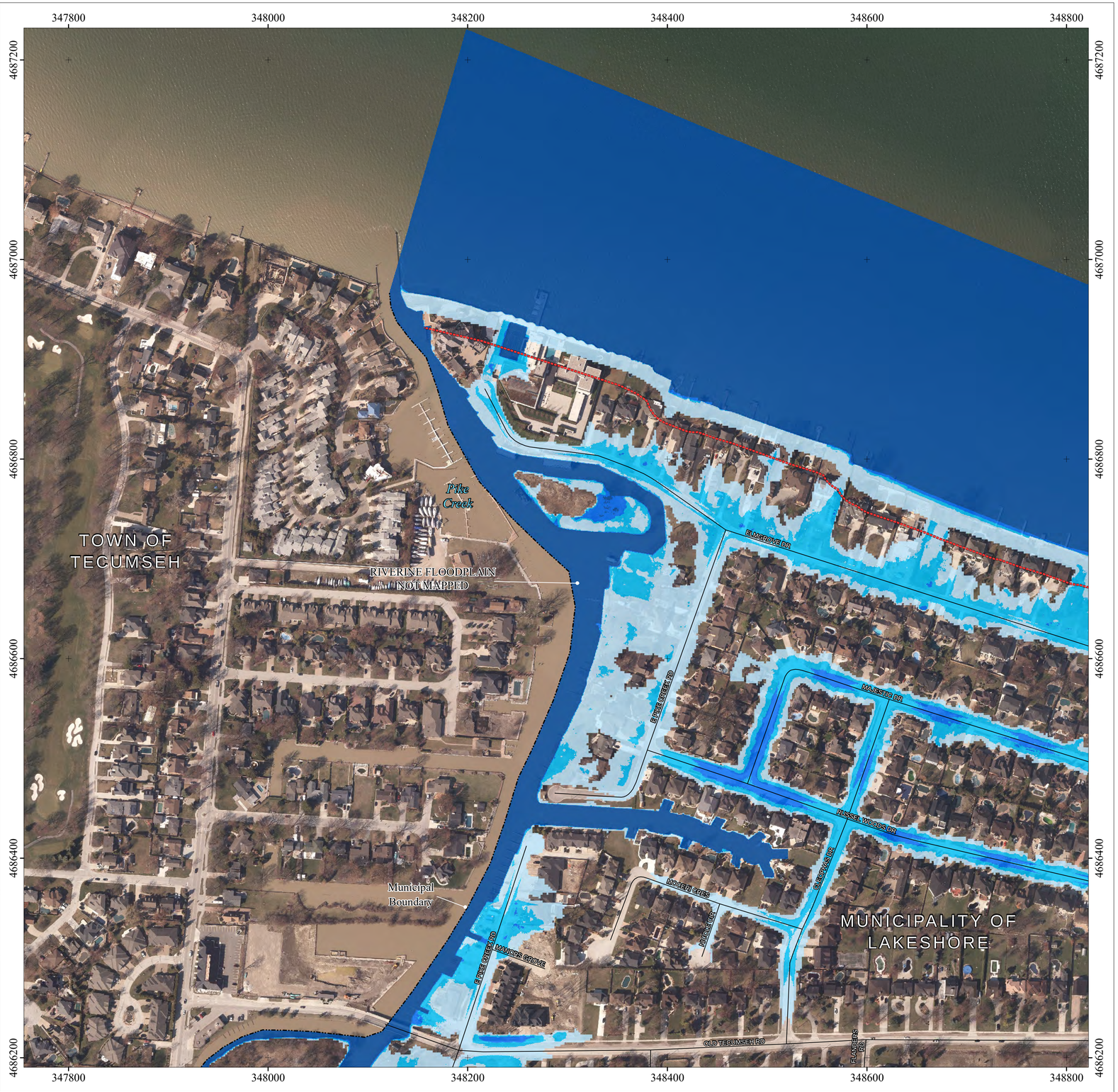
N W E S

PREPARED BY:

Zuzek inc. ONE WORLD

SJL ENGINEERING

Stantec



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MAP PUBLISHED APRIL 2021

Map 1 of 35

Municipality of Lakeshore Hazard Maps

Shoreline Management Plan

LEGEND:

- Erosion Hazard Limit
- Dynamic Beach Hazard Limit
- ERCA-LTVCA Boundary
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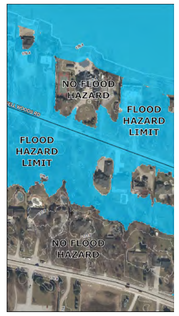

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0 50 100 200 m

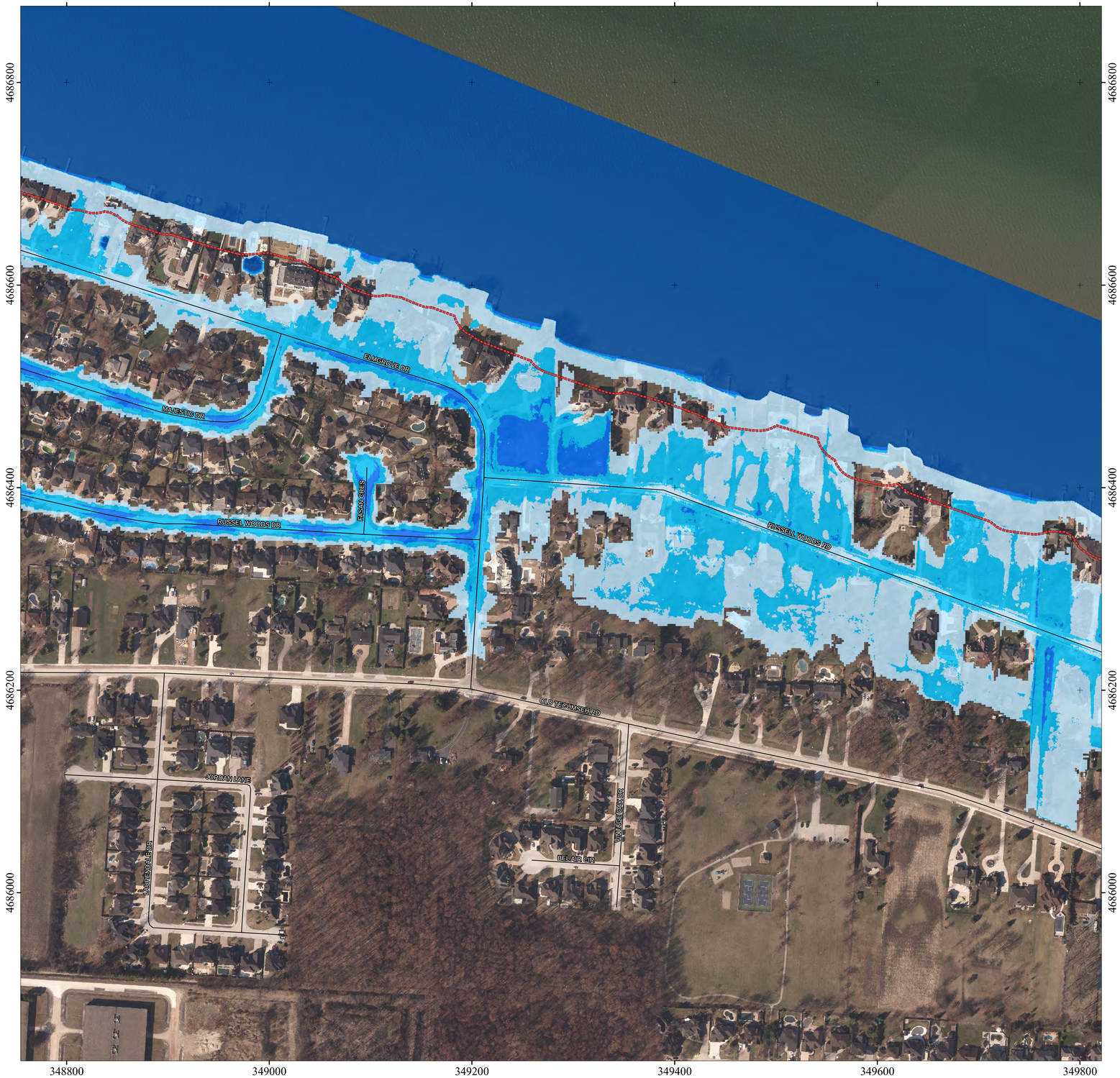
N W E S

PREPARED BY:

Zuzek inc. ONE WORLD

SJL ENGINEERING

Stantec



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MAP PUBLISHED APRIL 2021

Municipality of Lakeshore Hazard Maps

Shoreline Management Plan

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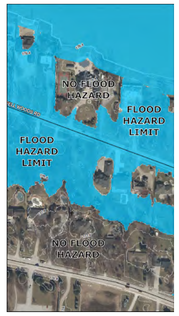

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0 50 100 200 m

N W E S

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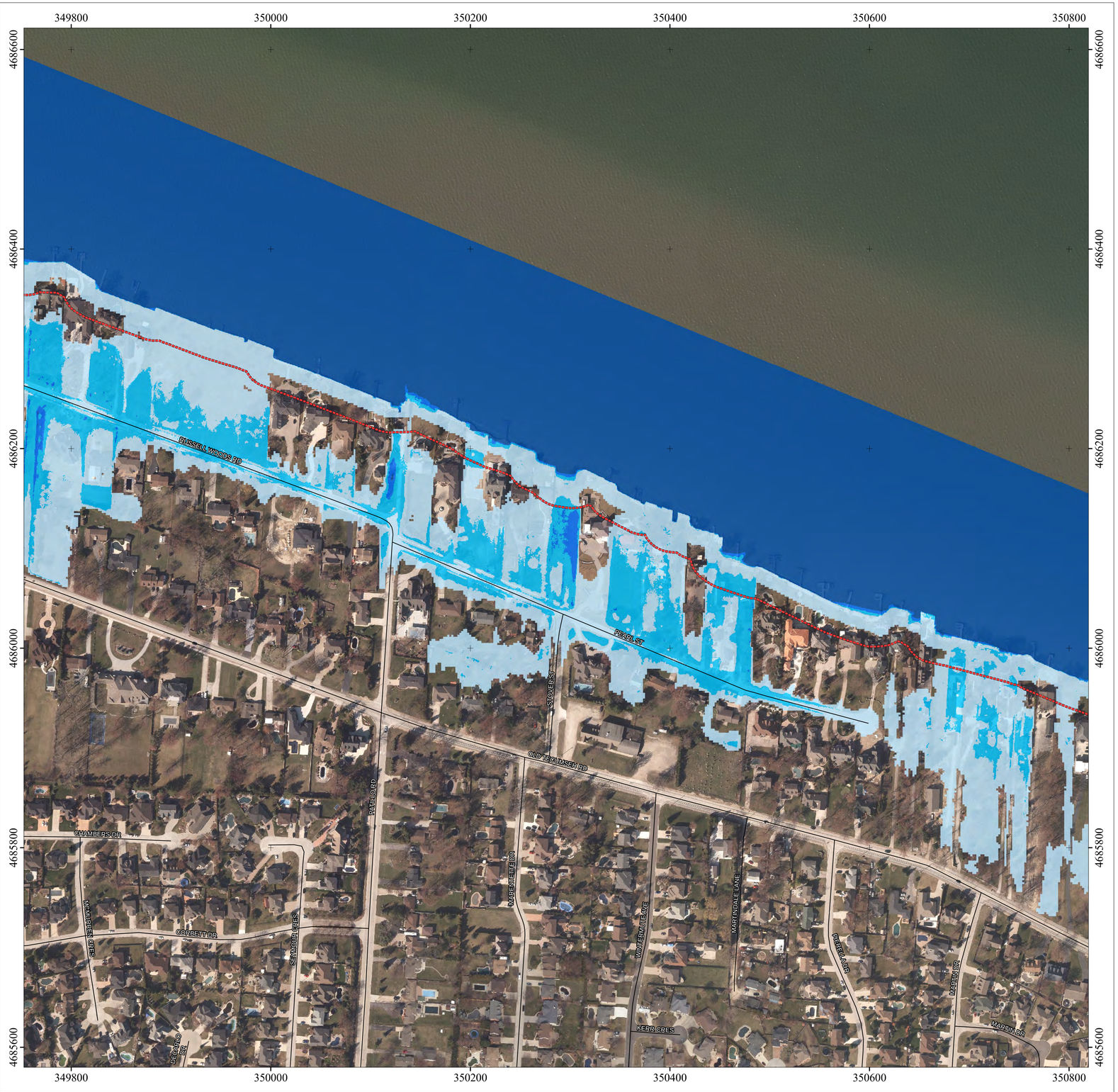

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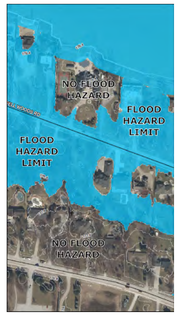

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0 50 100 200 m

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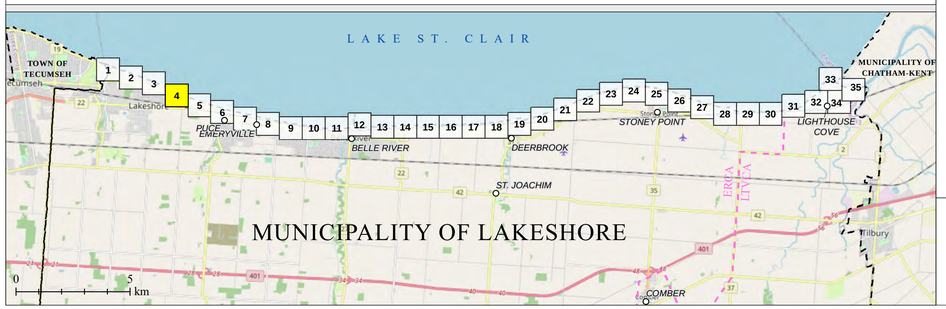
PREPARED BY:

Zuzek inc. ONE WORLD

SJL ENGINEERING

Stantec



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MAP PUBLISHED APRIL 2021

Map 4 of 35

MUNICIPALITY OF LAKESHORE HAZARD MAPS

SHORELINE MANAGEMENT PLAN

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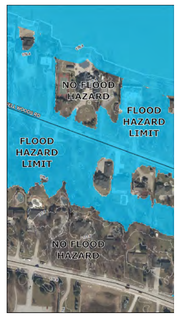

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Erosion Hazard Limit

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The Dynamic Beach Hazard Limit is defined as the sum of the Flood Hazard plus 30 metres measured inland horizontally. If local conditions transition to other land uses (e.g., roads, parking lots, buildings), the inland extent is the limit of the beach material. The offshore limit is approximately the 2 m depth contour.

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0 50 100 200 m

N W E S

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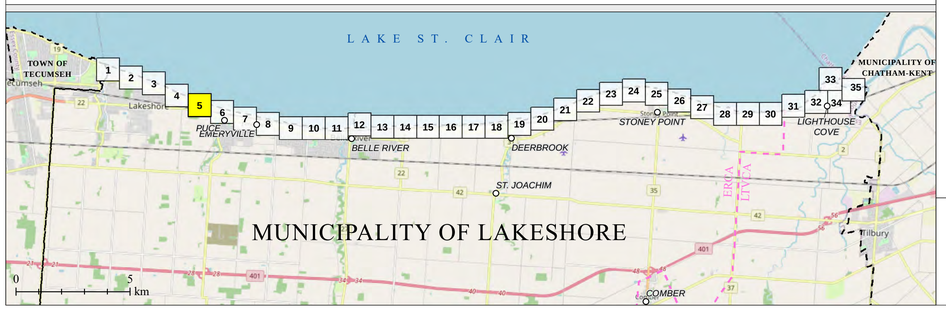
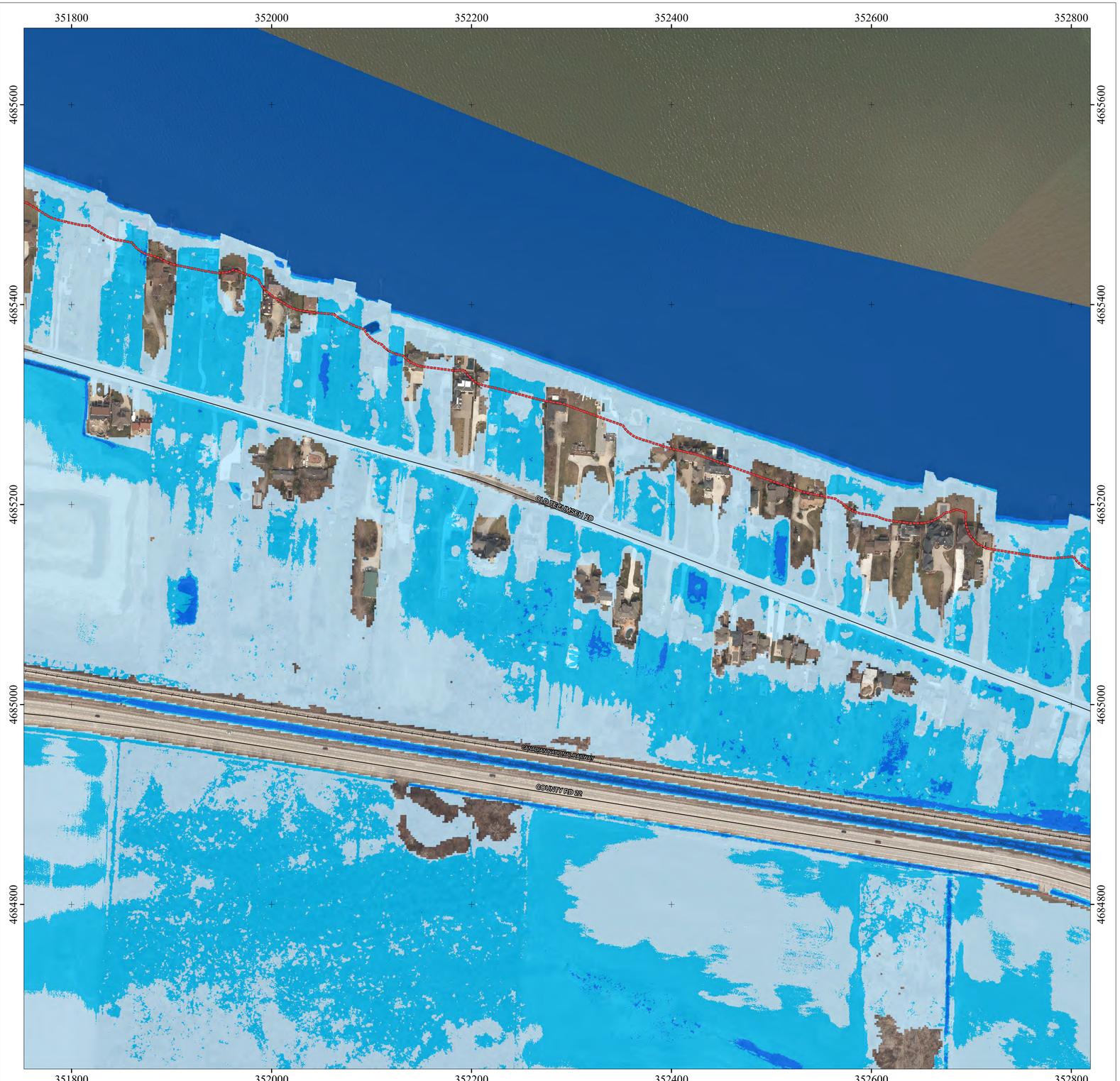
SJL ENGINEERING

Stantec





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MAP PUBLISHED APRIL 2021

Municipality of Lakeshore Hazard Maps

Shoreline Management Plan

LEGEND:

- Erosion Hazard Limit
- Dynamic Beach Hazard Limit
- ERCA-LTVCA Boundary
- Municipal Boundary

100-year Flood Hazard - Depth of Flooding (m)

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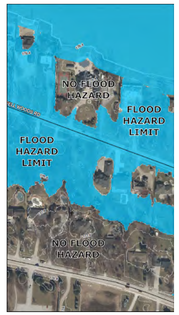

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0 50 100 200 m

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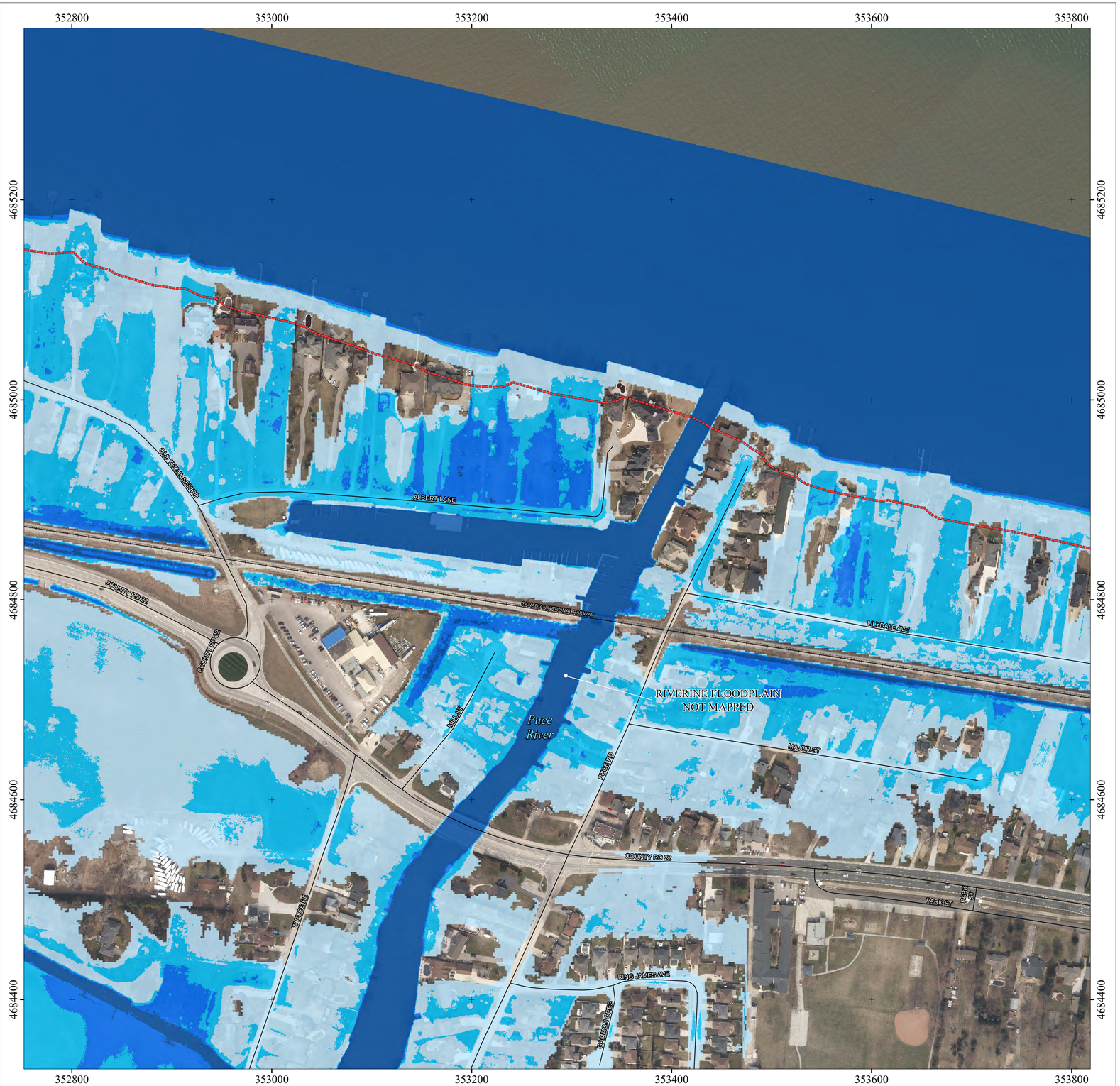

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MAP PUBLISHED APRIL 2021

Map 6 of 35

MUNICIPALITY OF LAKESHORE HAZARD MAPS

SHORELINE MANAGEMENT PLAN

LEGEND:

- Erosion Hazard Limit
- Dynamic Beach Hazard Limit
- ERCA-LTVCA Boundary
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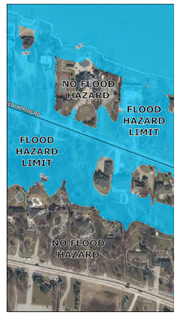

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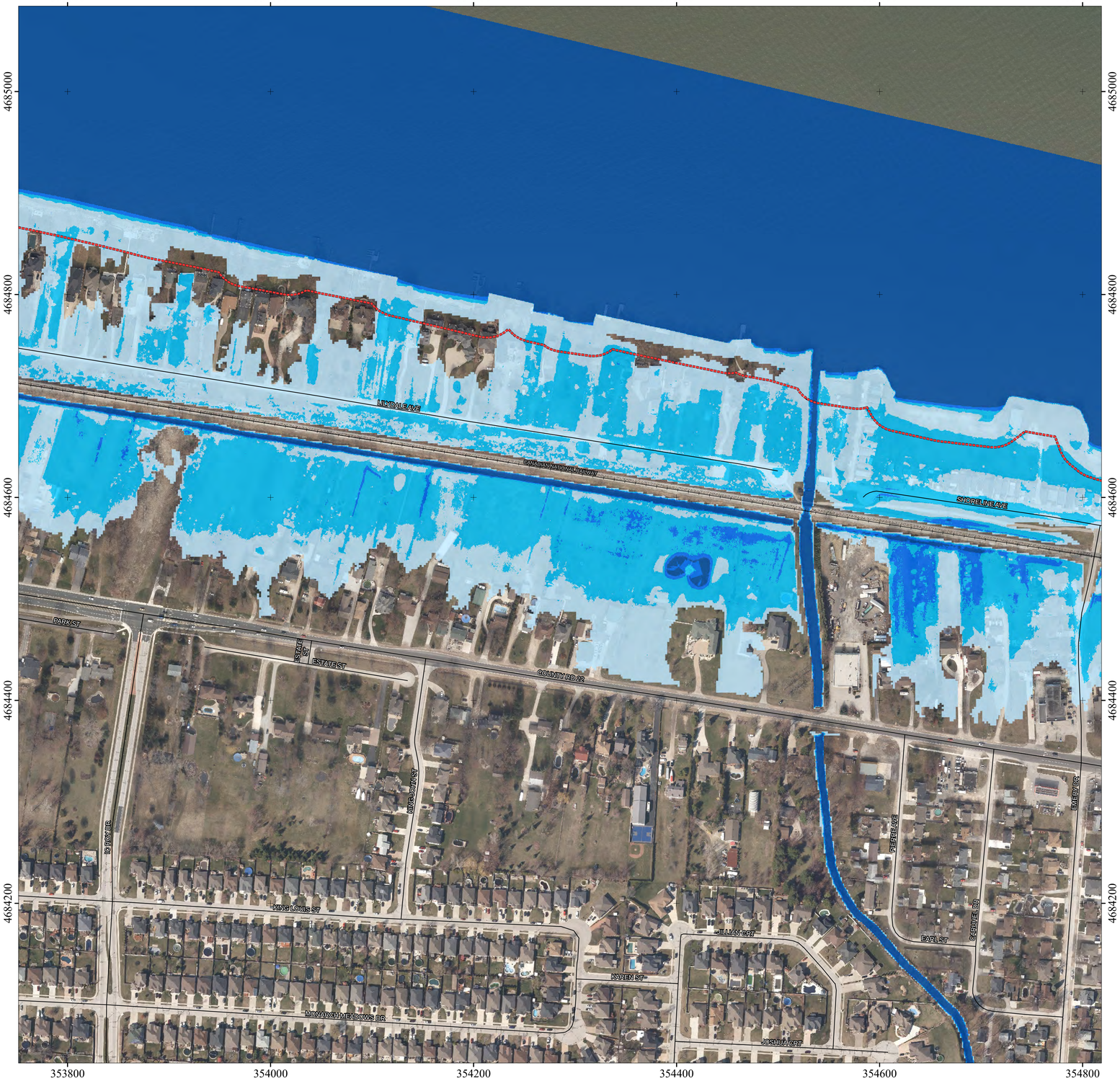
SJL ENGINEERING

Stantec



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MAP PUBLISHED APRIL 2021

Municipality of Lakeshore
Hazard Maps

SHORELINE MANAGEMENT PLAN

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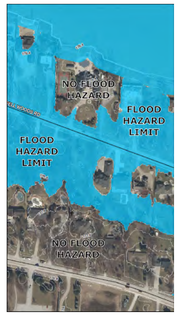

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SJL ENGINEERING

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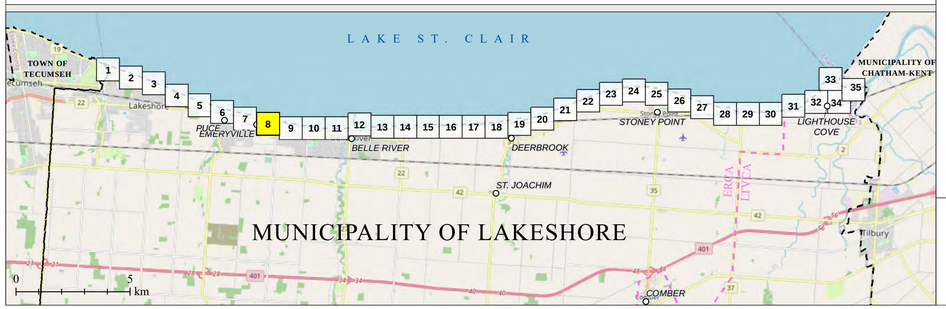

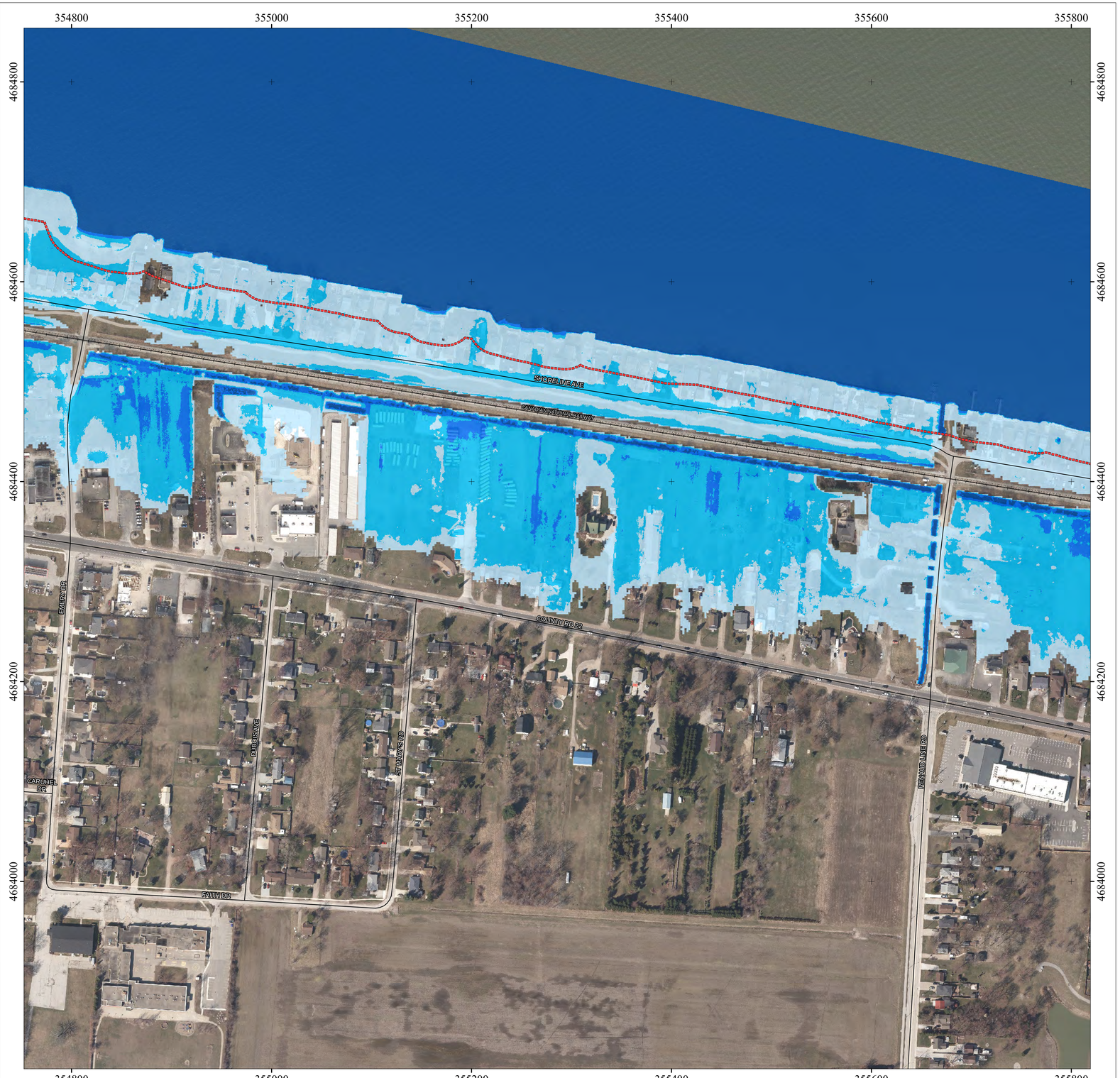

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MAP PUBLISHED APRIL 2021

Map 8 of 35

Municipality of Lakeshore Hazard Maps

Shoreline Management Plan

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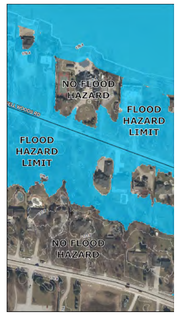

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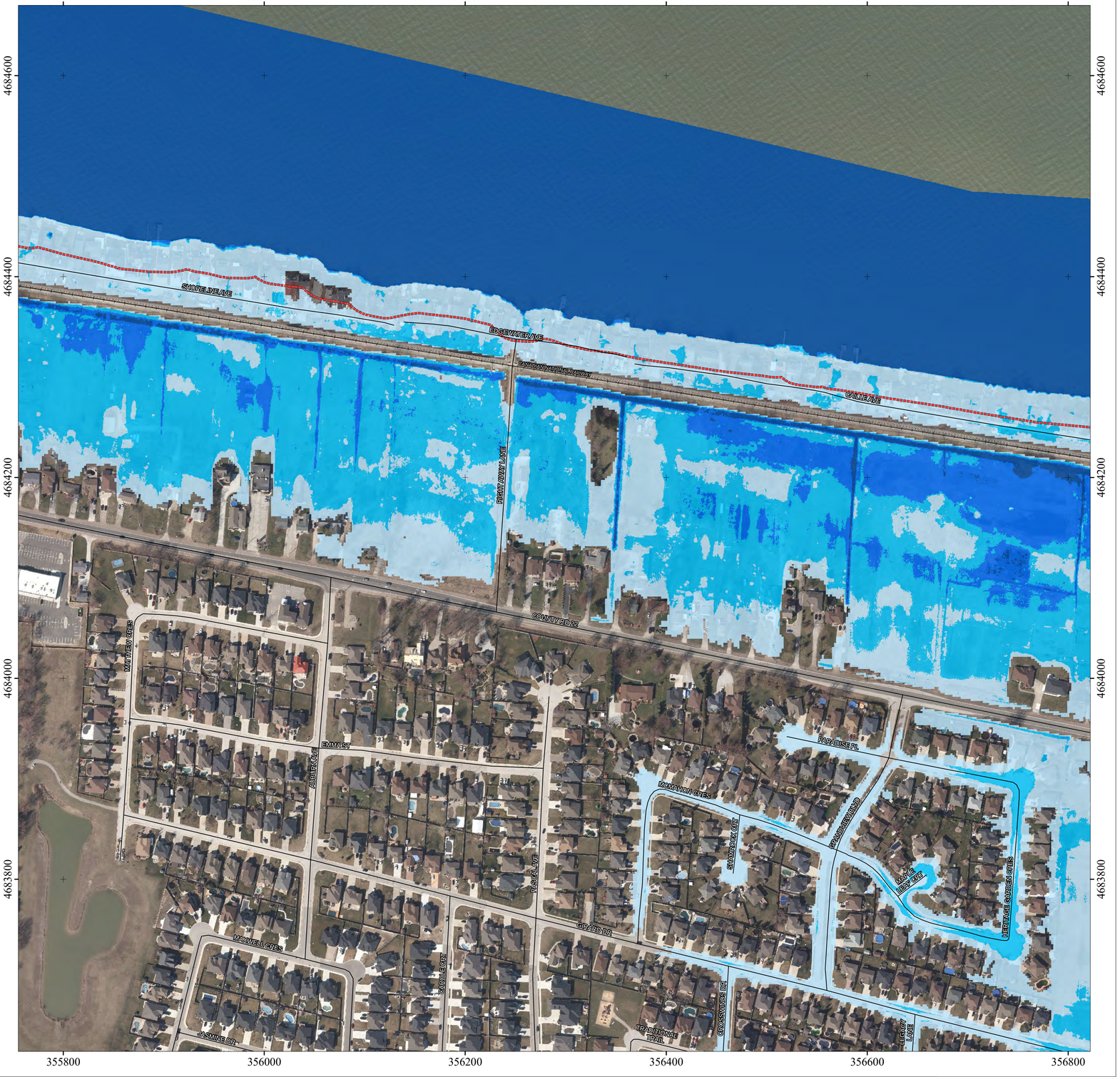

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Municipality of Lakeshore Hazard Maps

Shoreline Management Plan

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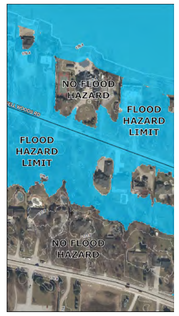

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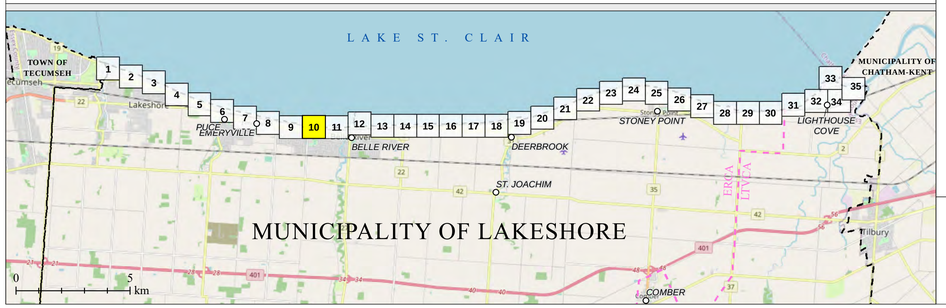

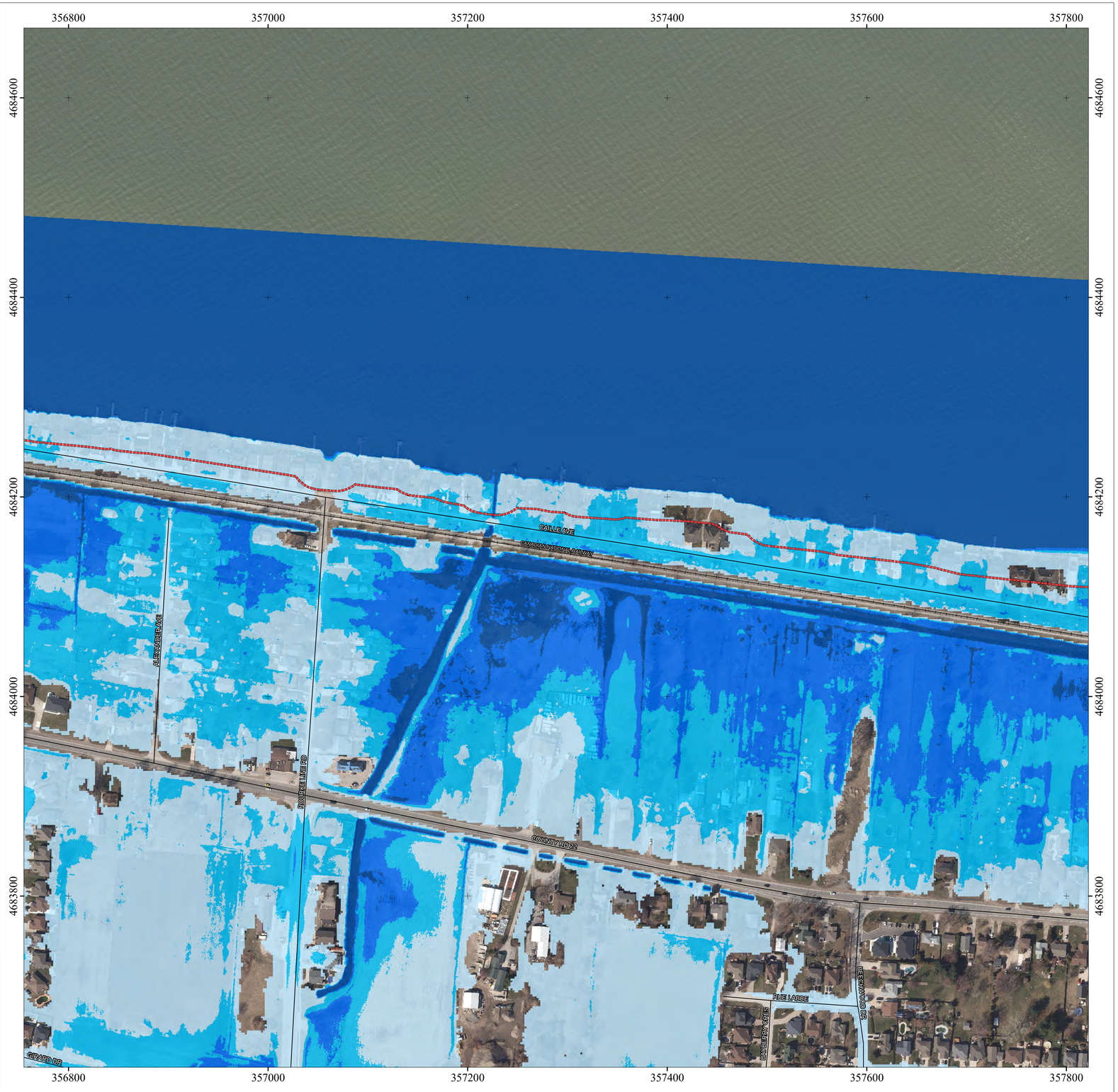

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MAP PUBLISHED APRIL 2021

Map 10 of 35

Municipality of Lakeshore Hazard Maps

Shoreline Management Plan

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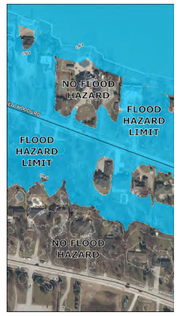

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0 50 100 200 m

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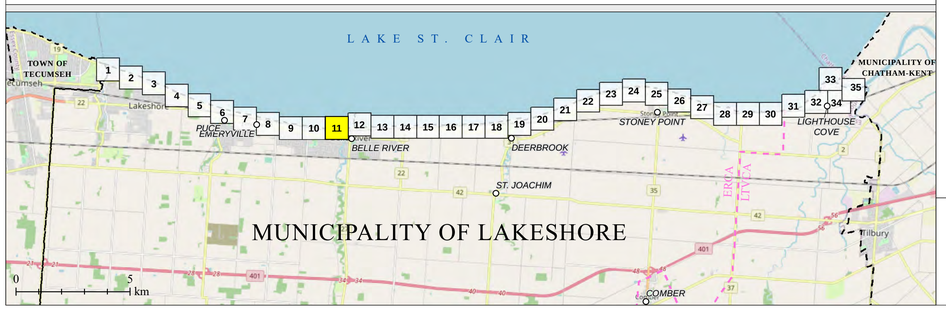
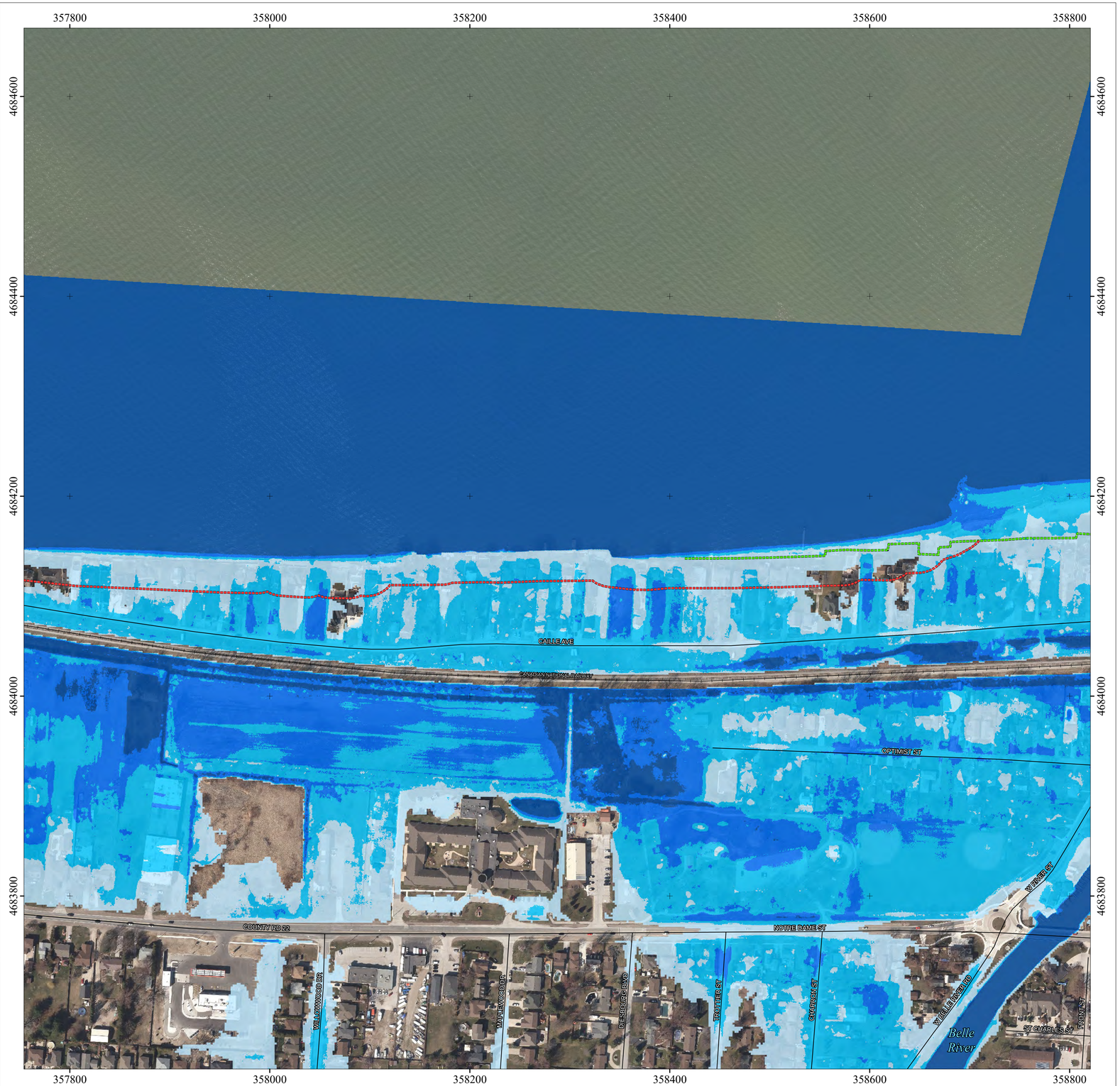
SJL ENGINEERING

Stantec





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MAP PUBLISHED APRIL 2021

MUNICIPALITY OF LAKESHORE HAZARD MAPS

SHORELINE MANAGEMENT PLAN

LEGEND:

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- Dynamic Beach Hazard Limit
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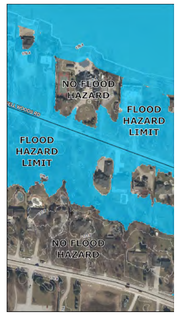

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0 50 100 200 m

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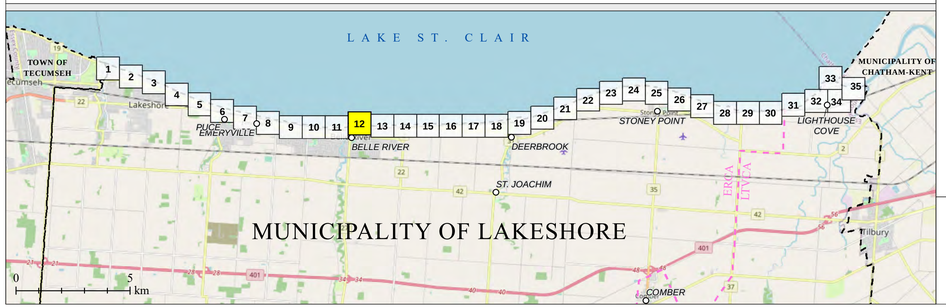
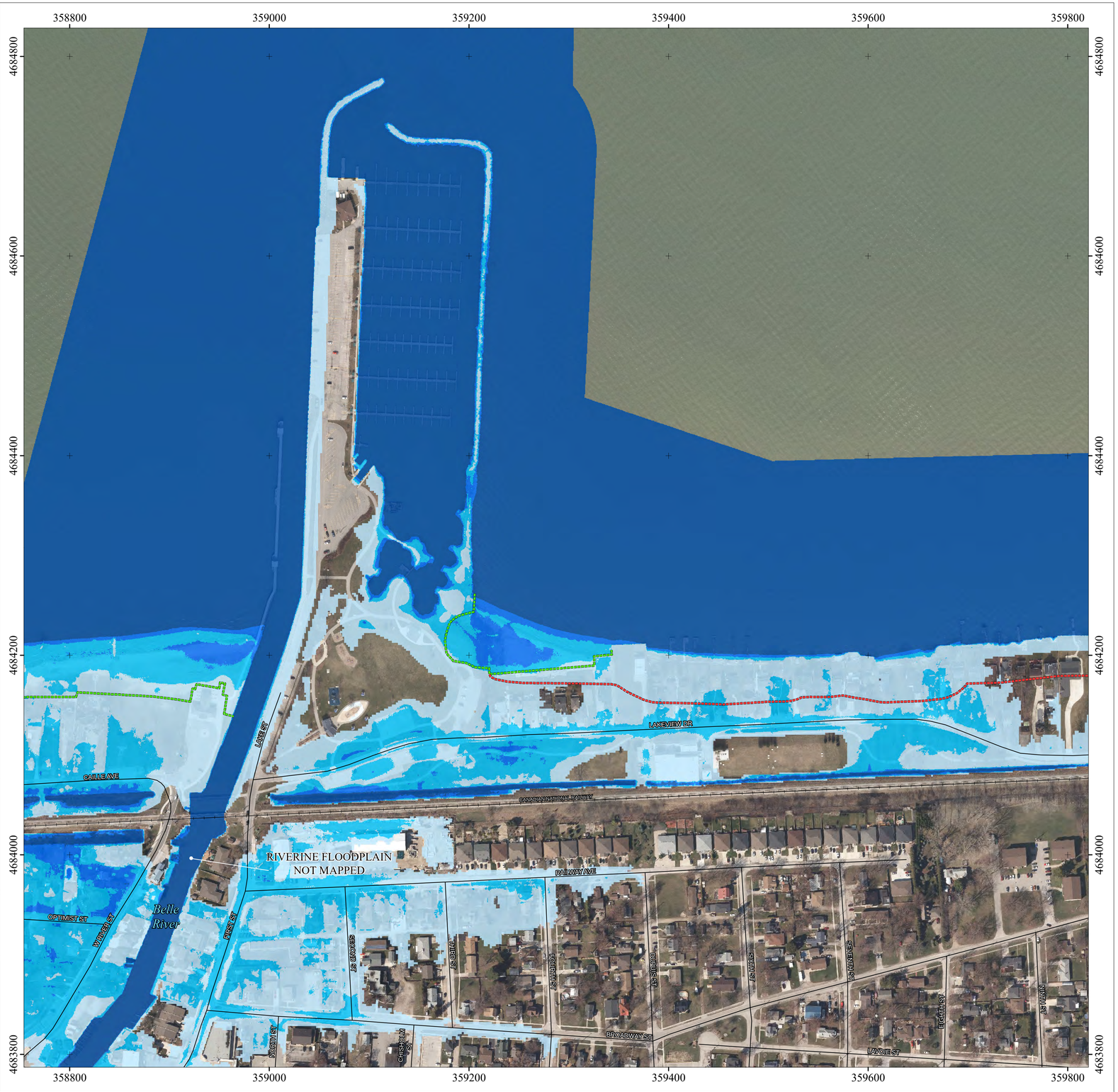
Stantec





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MAP PUBLISHED APRIL 2021

Municipality of Lakeshore Hazard Maps

Shoreline Management Plan

LEGEND:

- Erosion Hazard Limit
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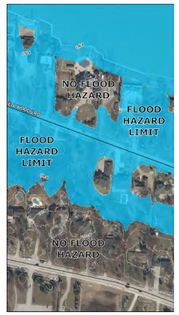

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0 50 100 200 m

N W E S

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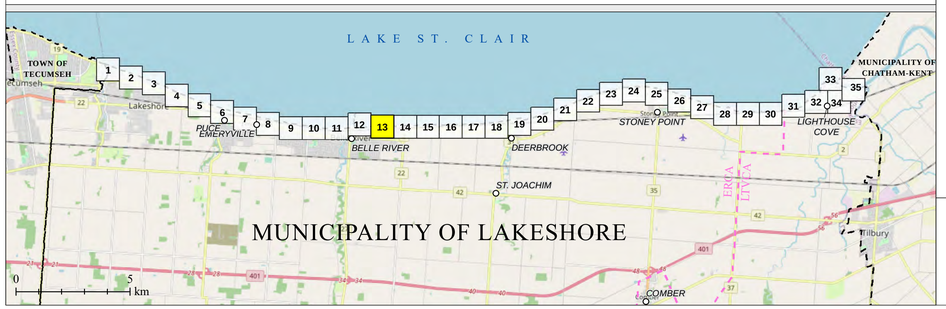
Zuzek inc. ONE WORLD

SJL ENGINEERING

Stantec



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MAP PUBLISHED APRIL 2021

Map 13 of 35

MUNICIPALITY OF LAKESHORE HAZARD MAPS

SHORELINE MANAGEMENT PLAN

LEGEND:

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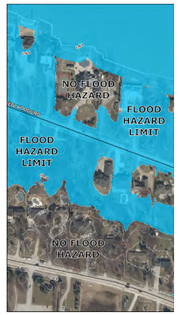

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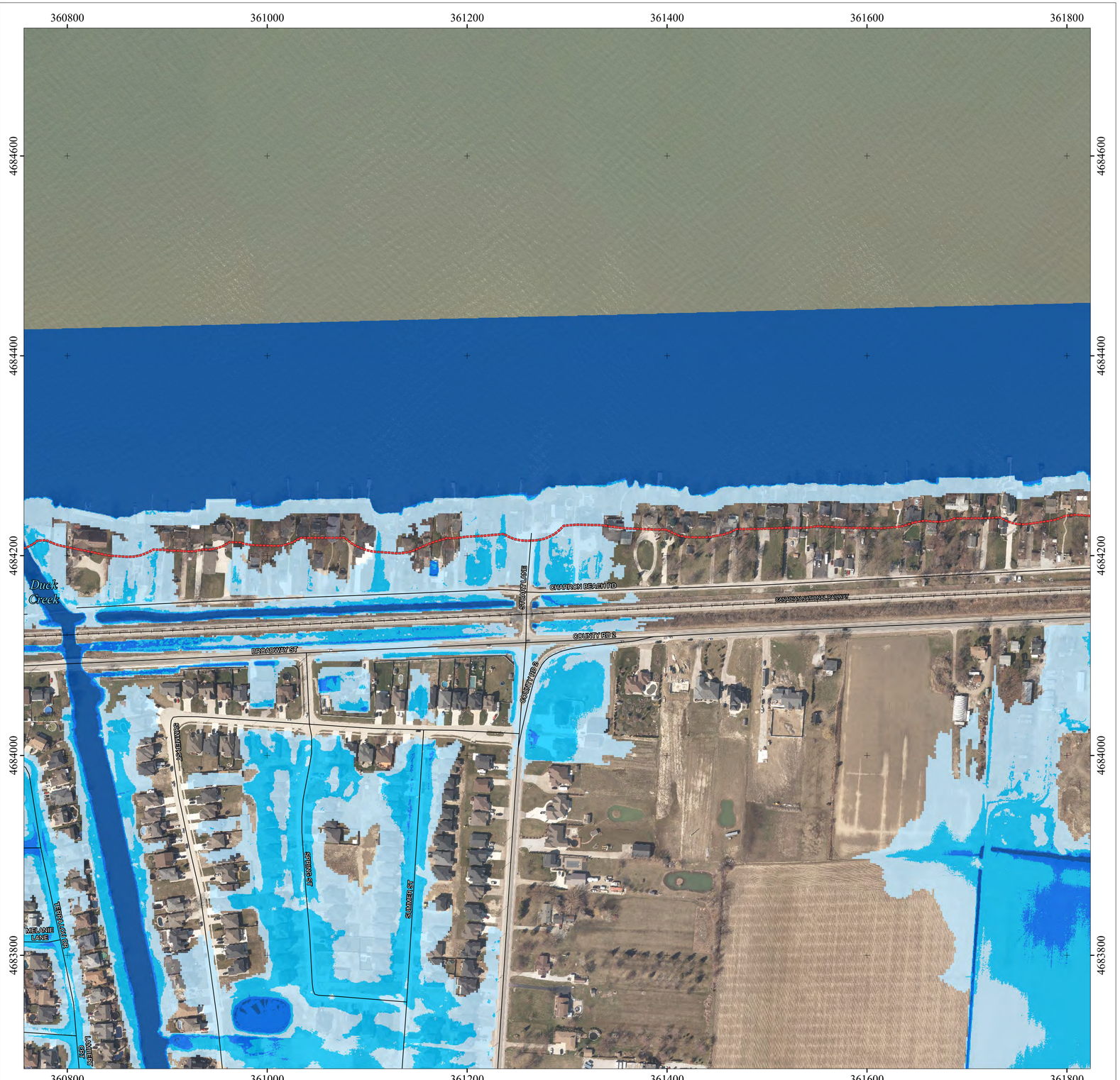
Stantec



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MUNICIPALITY OF LAKESHORE HAZARD MAPS

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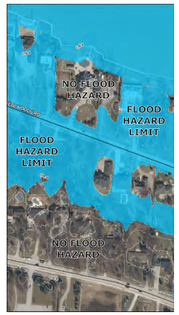

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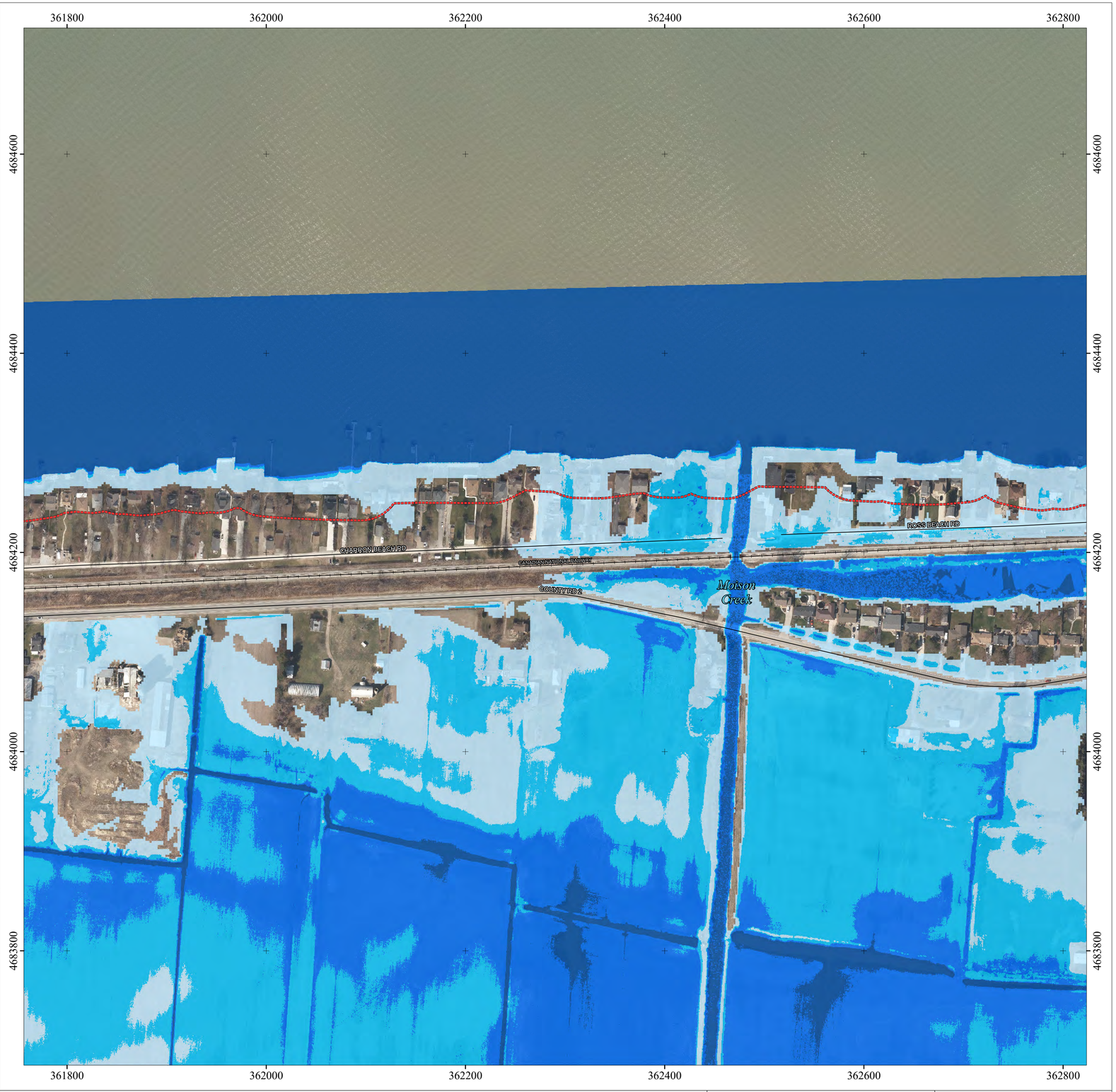

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Municipality of Lakeshore Hazard Maps

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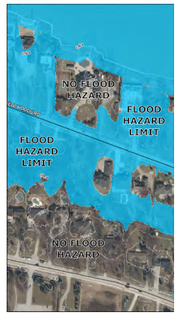

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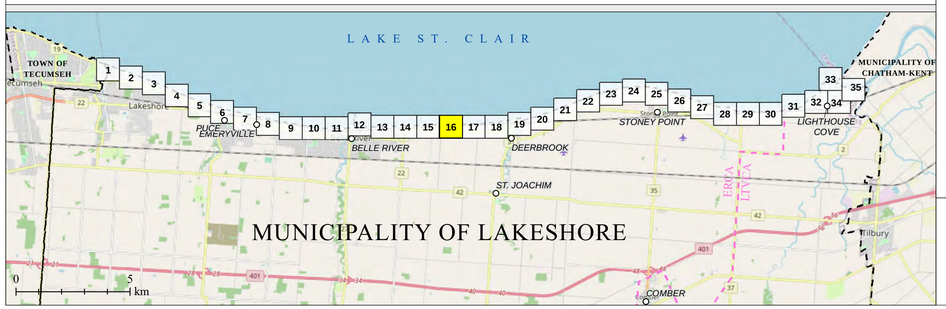

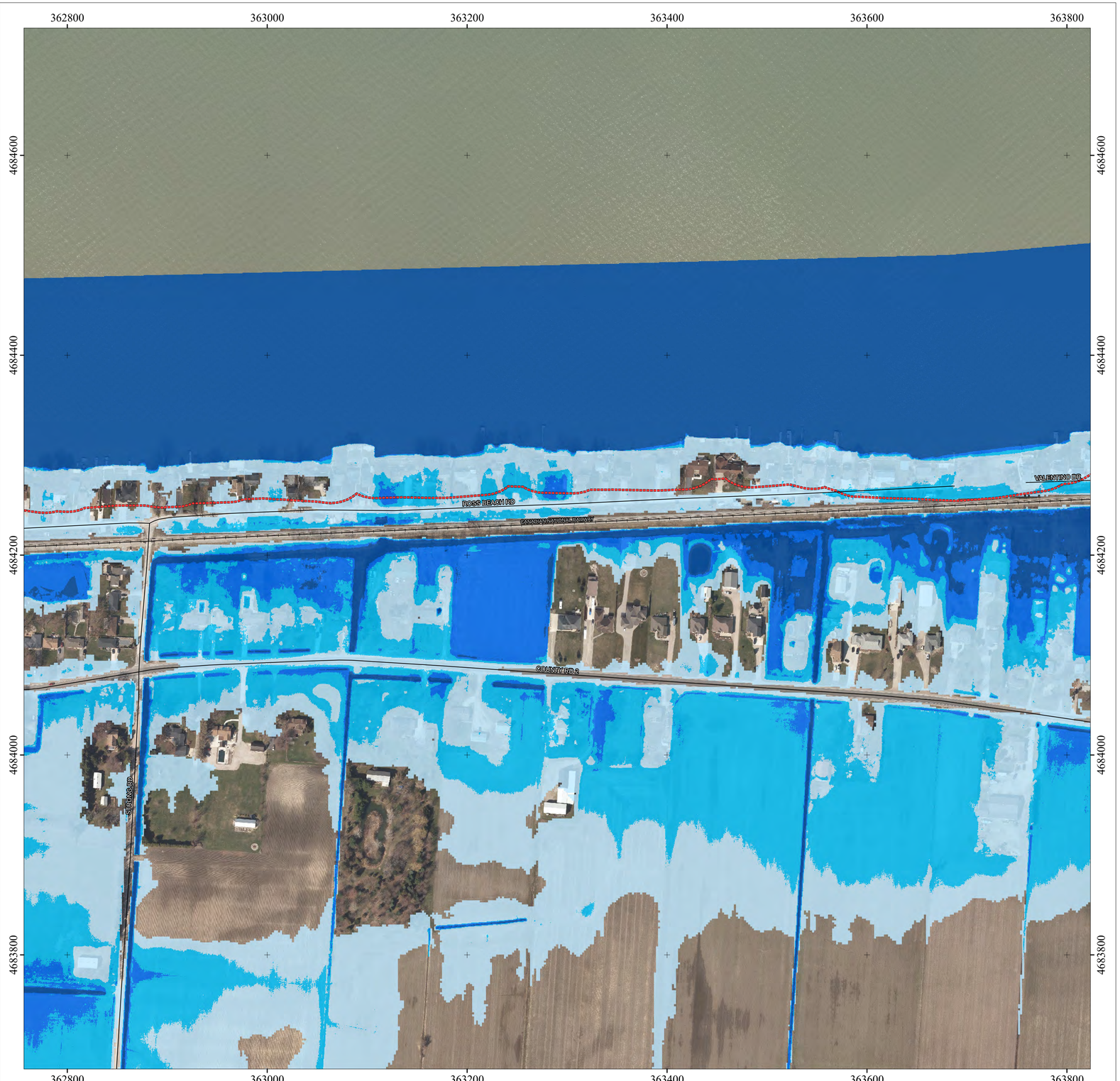

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MAP PUBLISHED APRIL 2021

Map 16 of 35

Municipality of Lakeshore Hazard Maps

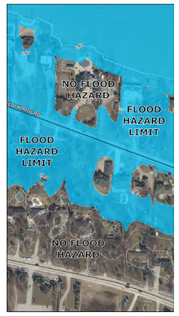
Shoreline Management Plan

LEGEND:

- Erosion Hazard Limit
- Dynamic Beach Hazard Limit
- ERCA-LTVCA Boundary
- Municipal Boundary

100-year Flood Hazard - Depth of Flooding (m)

- 0 - 0.3 m (Up to ~1 ft)
- 0.31 - 0.6 m (Up to ~2 ft)
- 0.61 - 0.9 m (Up to ~3 ft)
- > 0.9 m (> ~3 ft)



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0 50 100 200 m

N W E S

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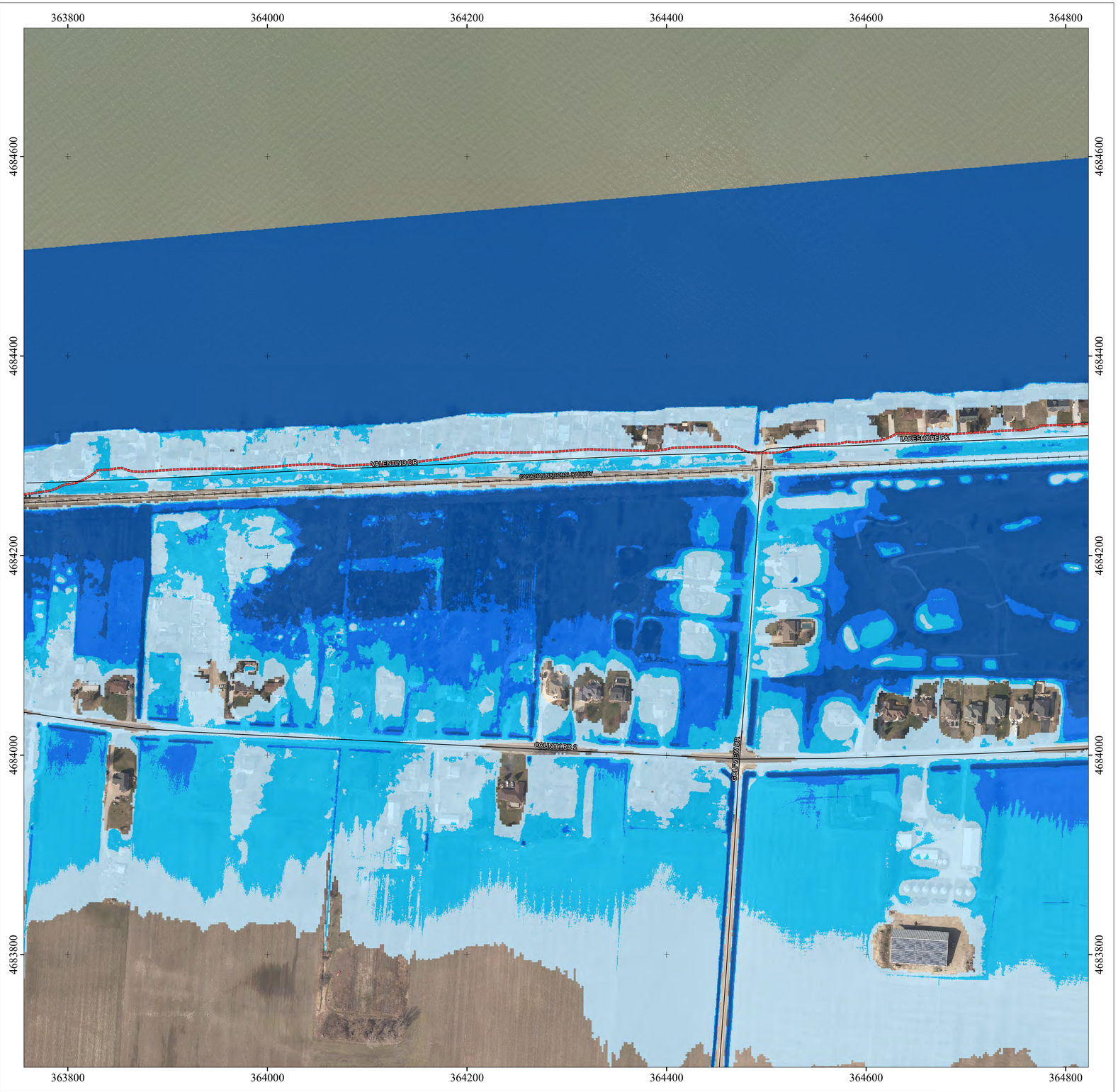
Zuzek inc. ONE WORLD

SJL ENGINEERING

Stantec



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MAP PUBLISHED APRIL 2021

Municipality of Lakeshore Hazard Maps

Shoreline Management Plan

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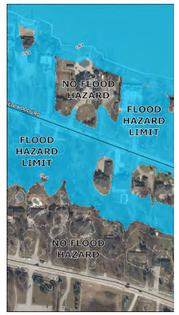

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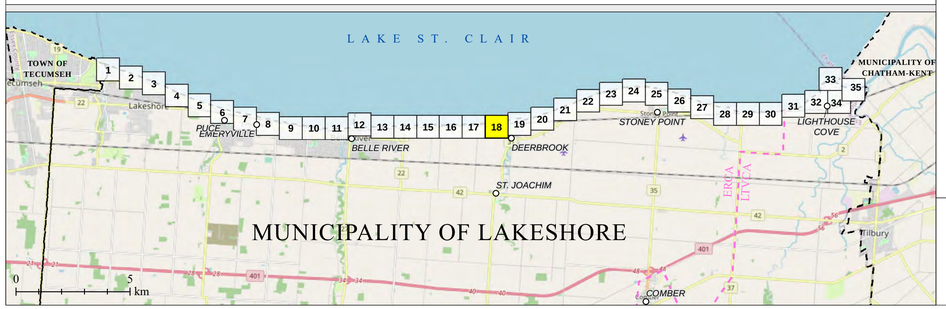
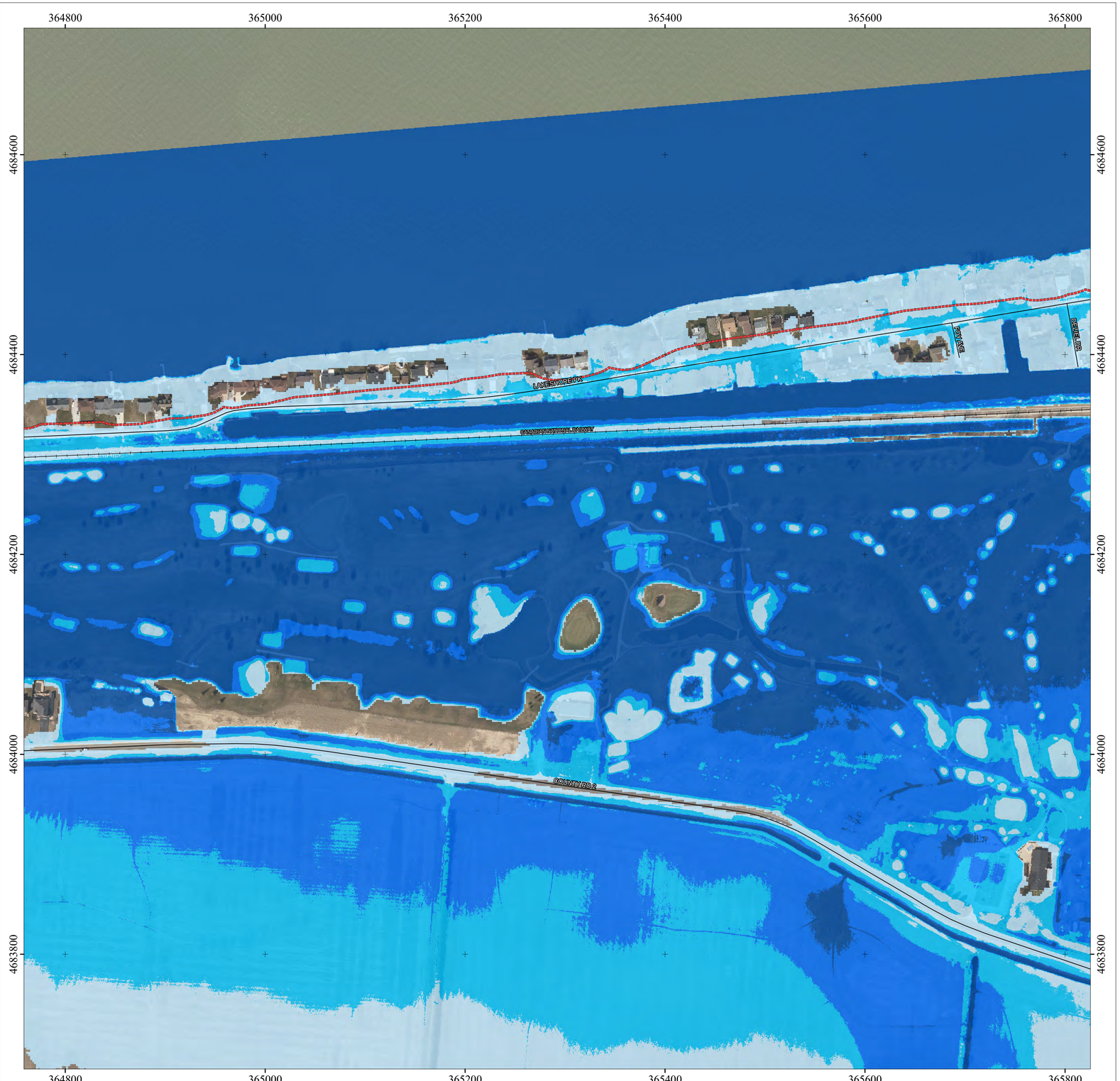
SJL ENGINEERING

Stantec





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Map 18 of 35

MUNICIPALITY OF LAKESHORE HAZARD MAPS

SHORELINE MANAGEMENT PLAN

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- Erosion Hazard Limit
- Dynamic Beach Hazard Limit
- ERCA-LTVCA Boundary
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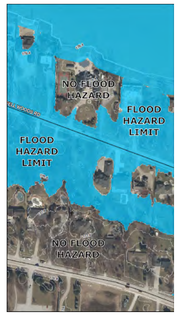

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0 50 100 200 m

N W E S

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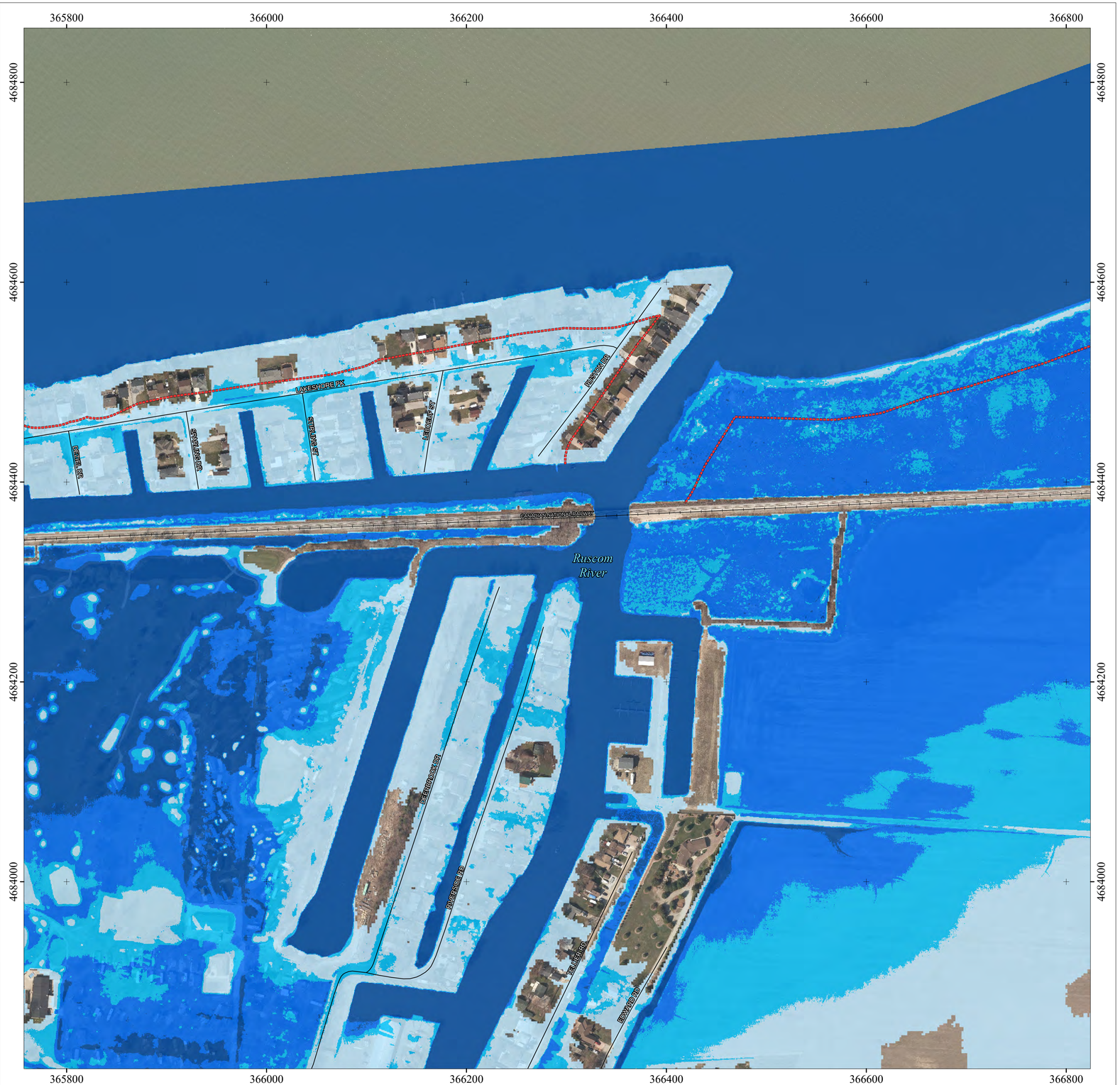
Stantec



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Map 19 of 35

Municipality of Lakeshore Hazard Maps

Shoreline Management Plan

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- Dynamic Beach Hazard Limit
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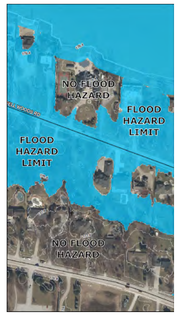

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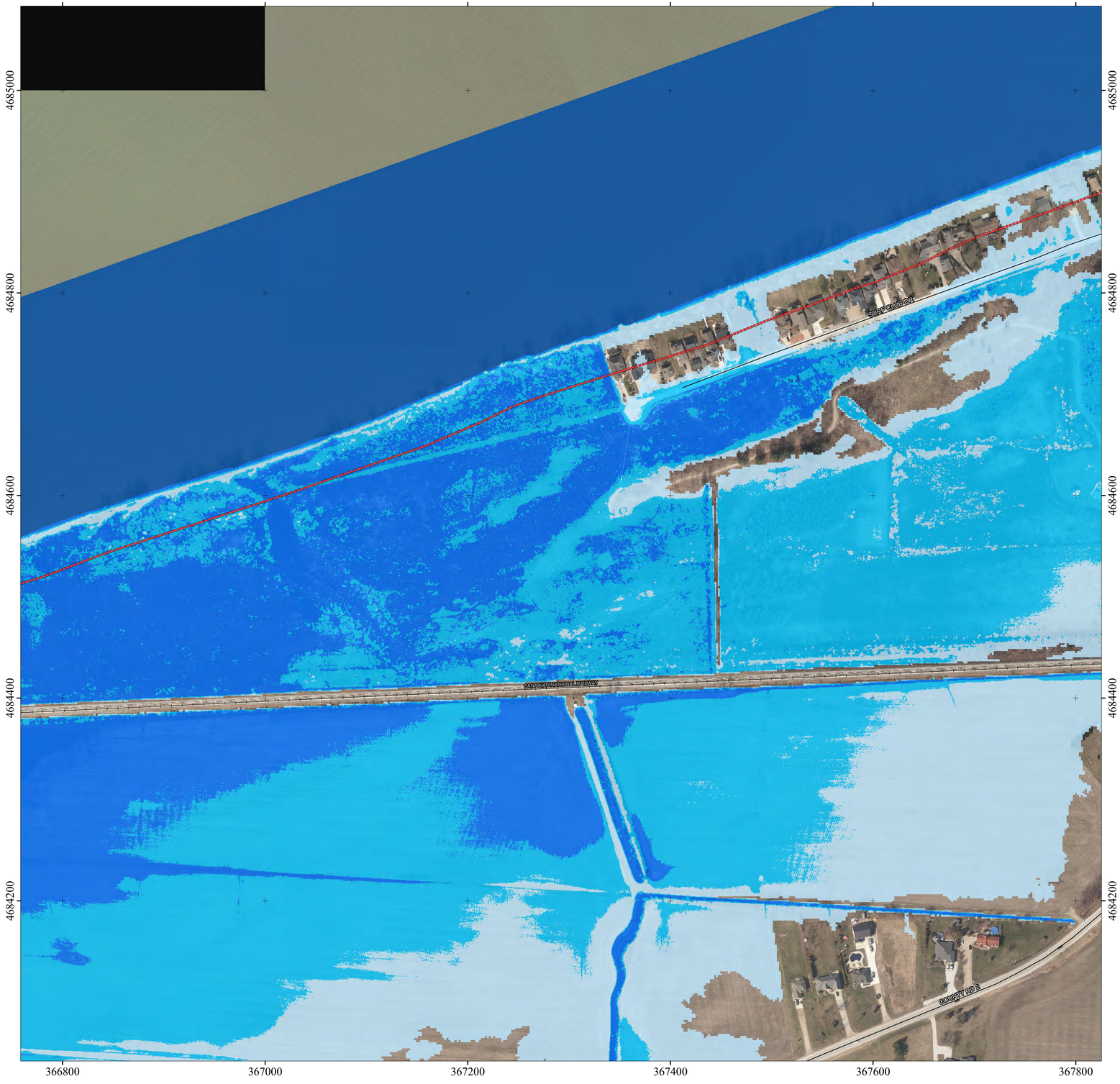

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Map 20 of 35

Municipality of Lakeshore Hazard Maps

Shoreline Management Plan

LEGEND:

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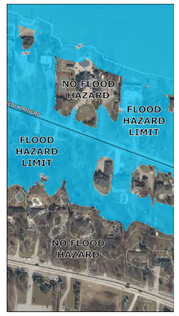

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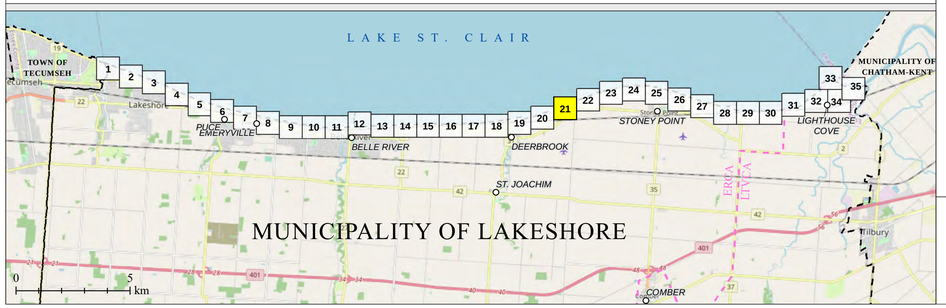

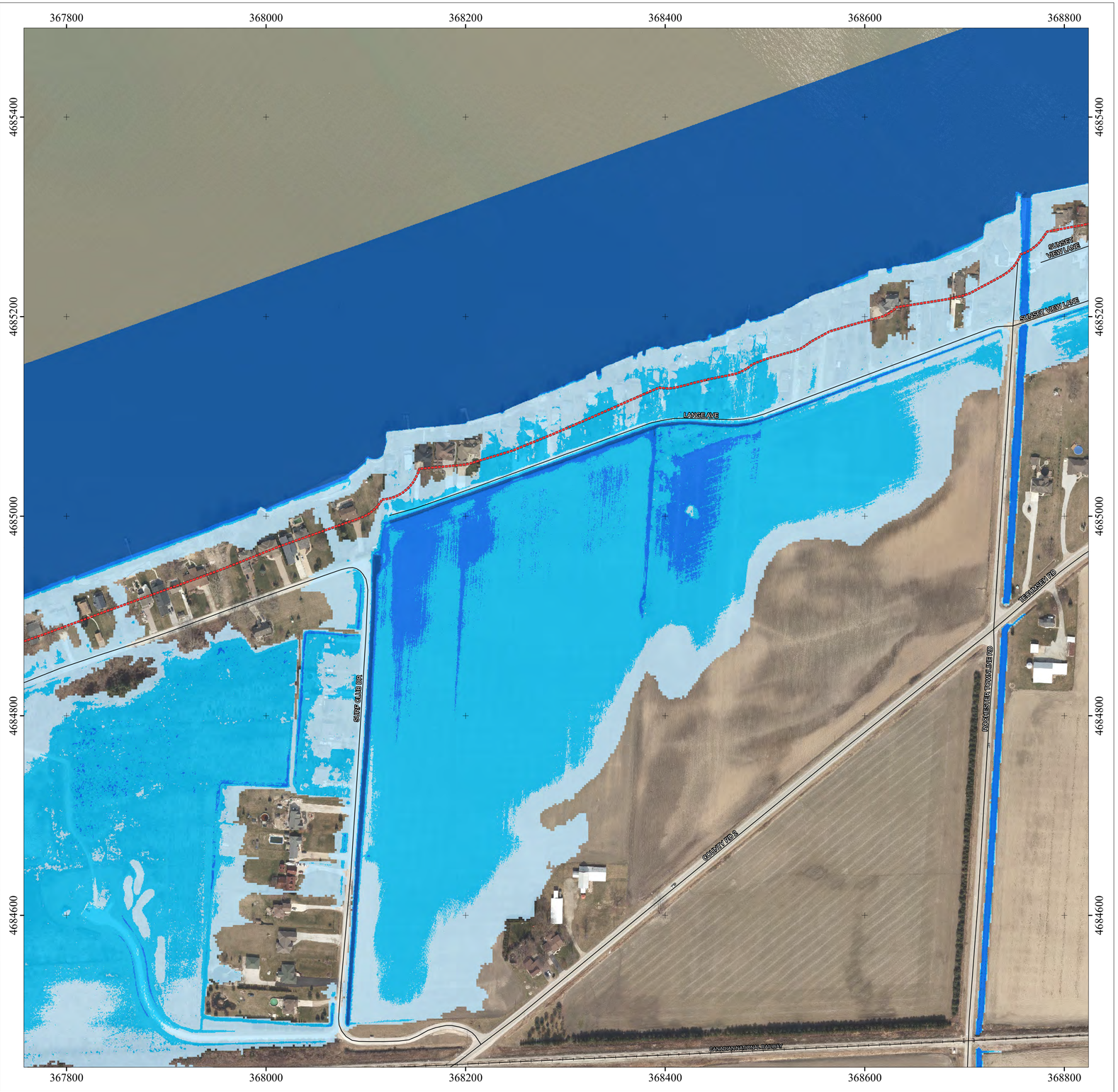

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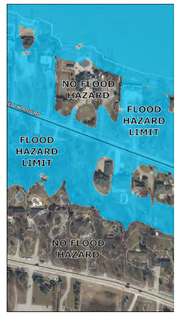

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Municipality of Lakeshore
Hazard Maps

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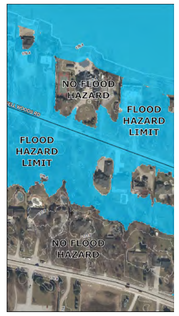

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Erosion Hazard Limit

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The Dynamic Beach Hazard Limit is defined as the sum of the Flood Hazard plus 30 metres measured inland horizontally. If local conditions transition to other land uses (e.g., roads, parking lots, buildings), the inland extent is the limit of the beach material. The offshore limit is approximately the 2 m depth contour.

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0 50 100 200 m

N W E S

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Zuzek inc. ONE WORLD

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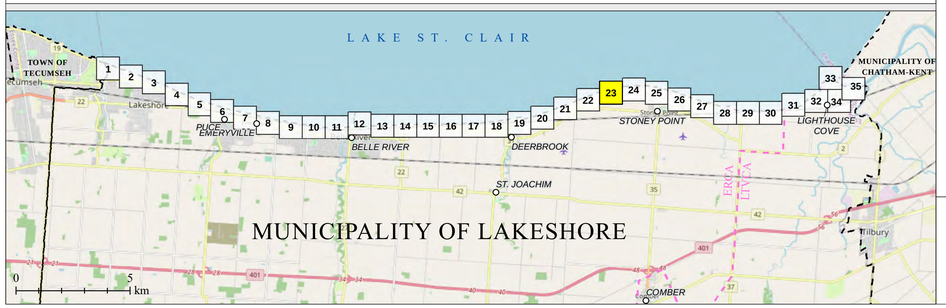
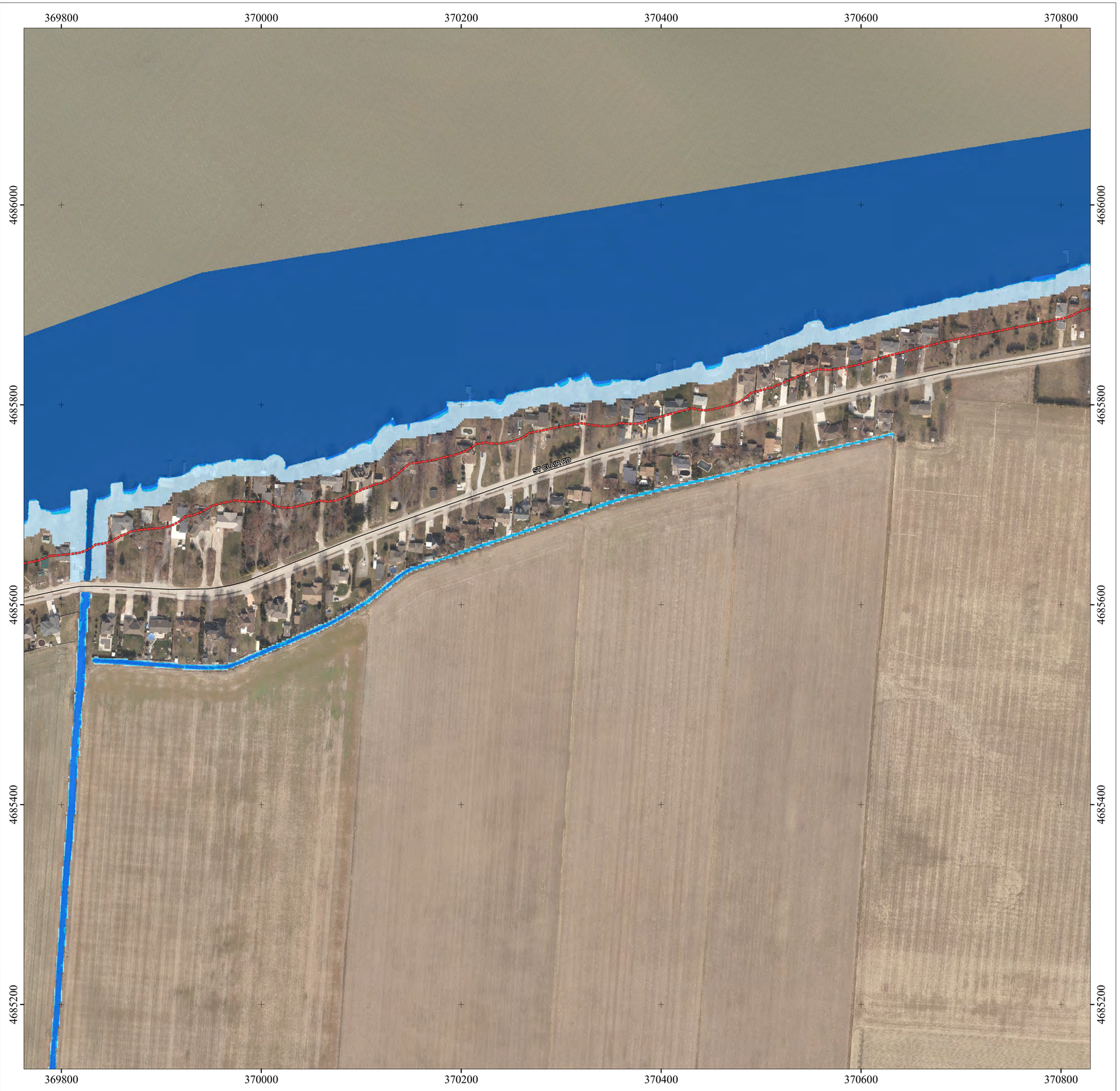
Stantec





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MAP PUBLISHED APRIL 2021

Map 23 of 35

MUNICIPALITY OF LAKESHORE HAZARD MAPS

SHORELINE MANAGEMENT PLAN

LEGEND:

- Erosion Hazard Limit
- Dynamic Beach Hazard Limit
- ERCA-LTVCA Boundary
- Municipal Boundary

100-year Flood Hazard - Depth of Flooding (m)

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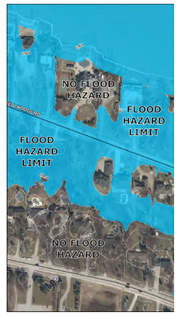

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DEFINITIONS:

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0 50 100 200 m

N W E S

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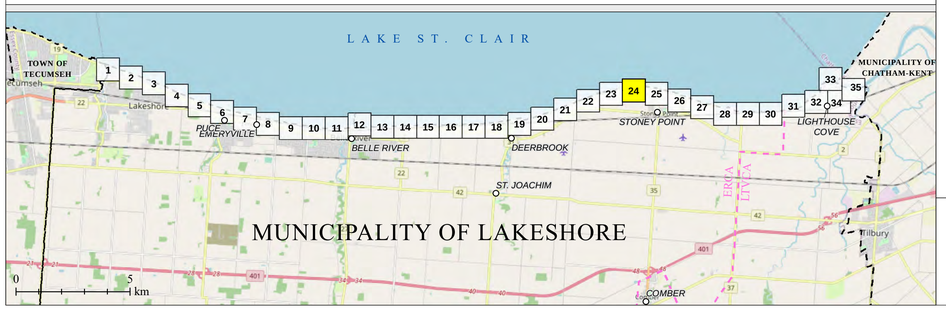
Stantec



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MAP PUBLISHED APRIL 2021

Map 24 of 35

Municipality of Lakeshore Hazard Maps

Shoreline Management Plan

LEGEND:

- Erosion Hazard Limit
- Dynamic Beach Hazard Limit
- ERCA-LTVCA Boundary
- Municipal Boundary

100-year Flood Hazard - Depth of Flooding (m)

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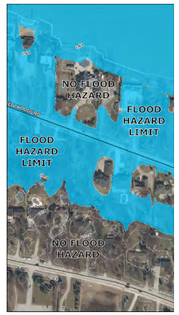

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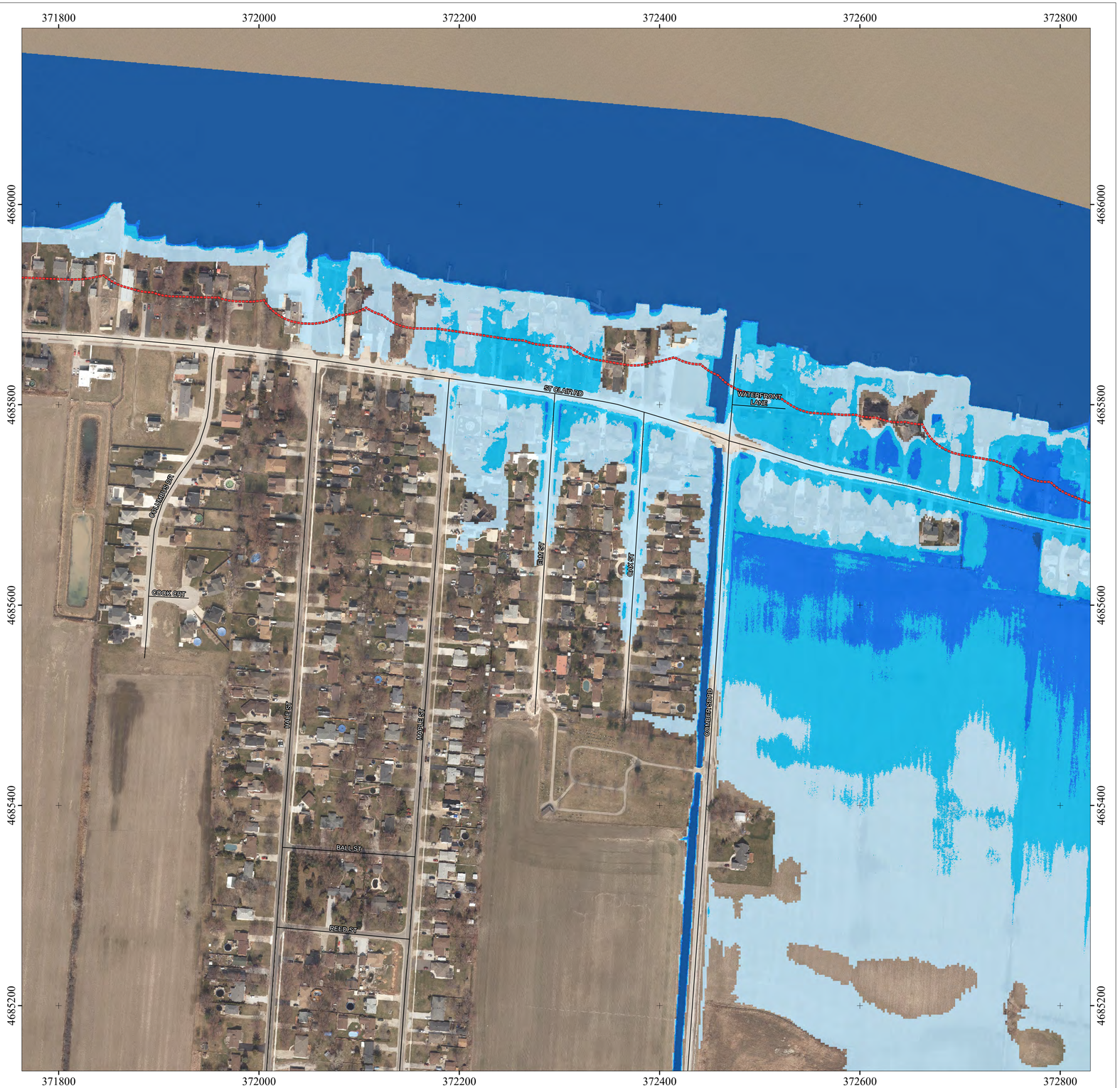
0 50 100 200 m

N W E S



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Map 25 of 35

Municipality of Lakeshore Hazard Maps

Shoreline Management Plan

LEGEND:

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- Dynamic Beach Hazard Limit
- ERCA-LTVCA Boundary
- Municipal Boundary

100-year Flood Hazard - Depth of Flooding (m)

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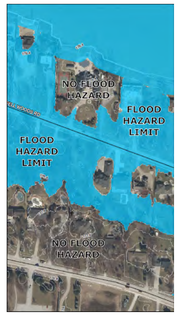

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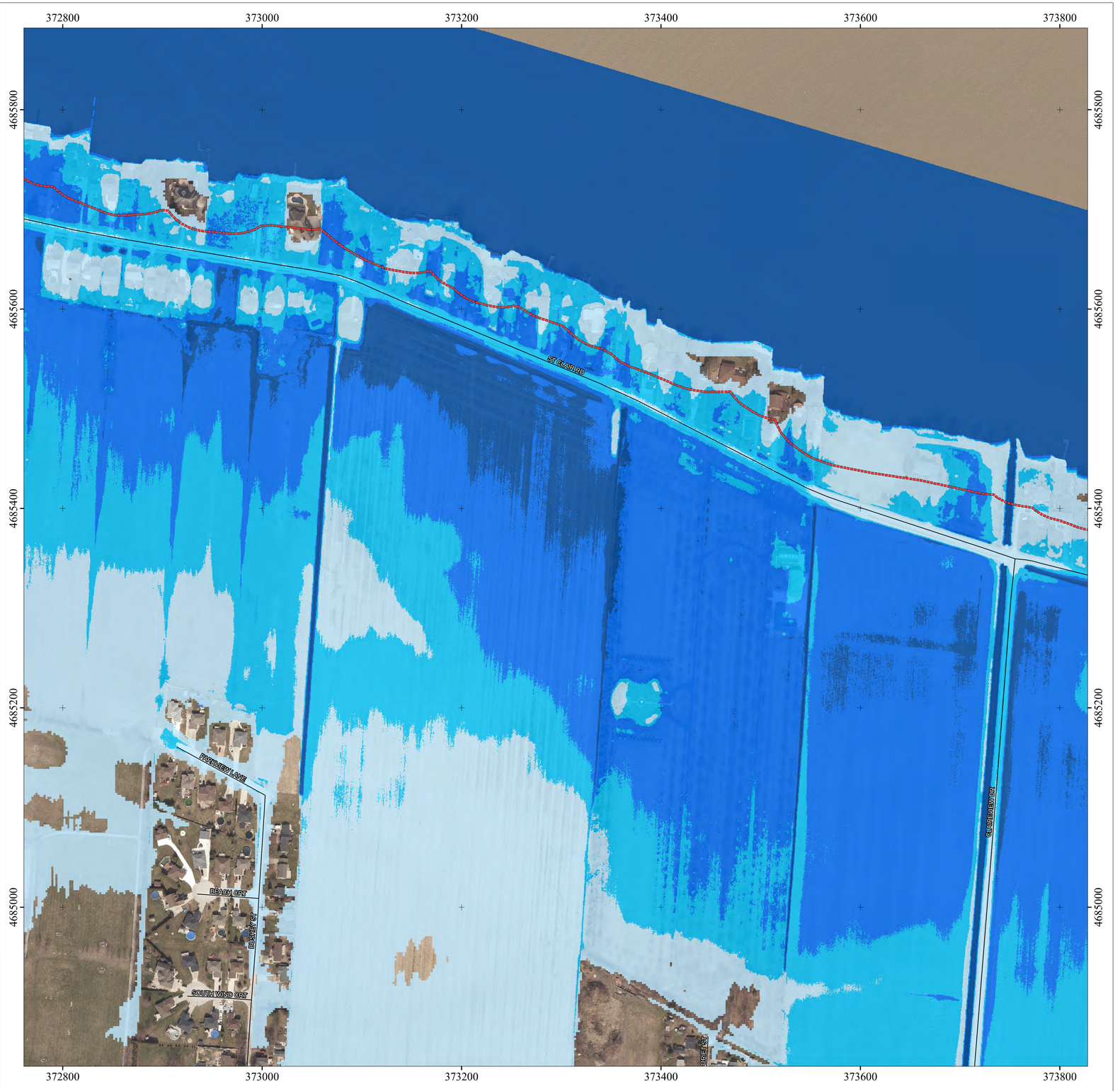
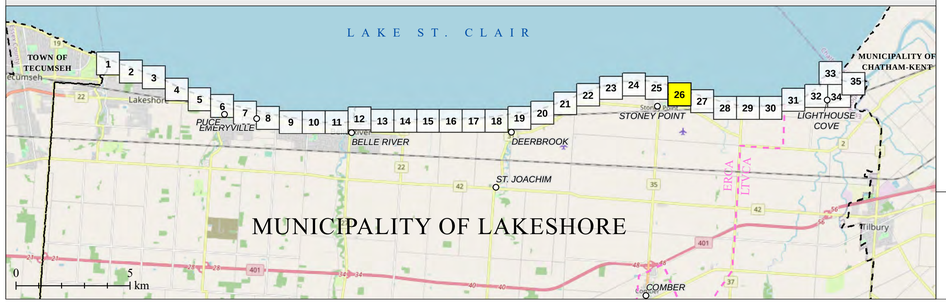
0 50 100 200 m

N W E S





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SJL ENGINEERING

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MAP PUBLISHED APRIL 2021

Map 26 of 35

Municipality of Lakeshore Hazard Maps

Shoreline Management Plan

LEGEND:

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- Municipal Boundary

100-year Flood Hazard - Depth of Flooding (m)

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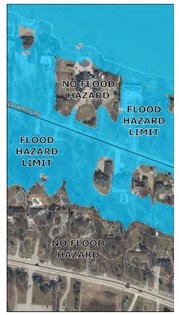

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0 50 100 200 m

N W E S

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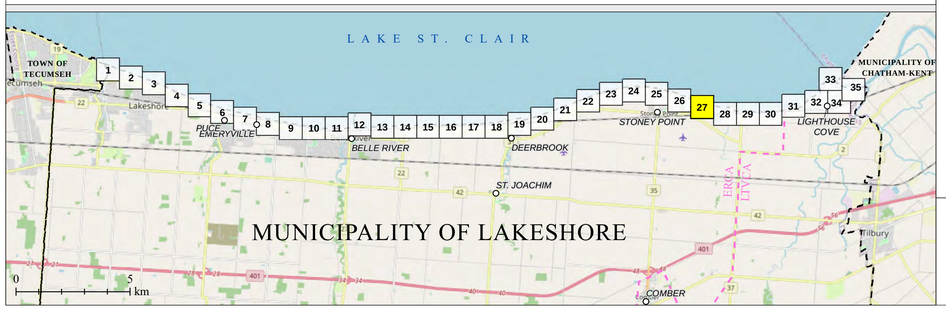

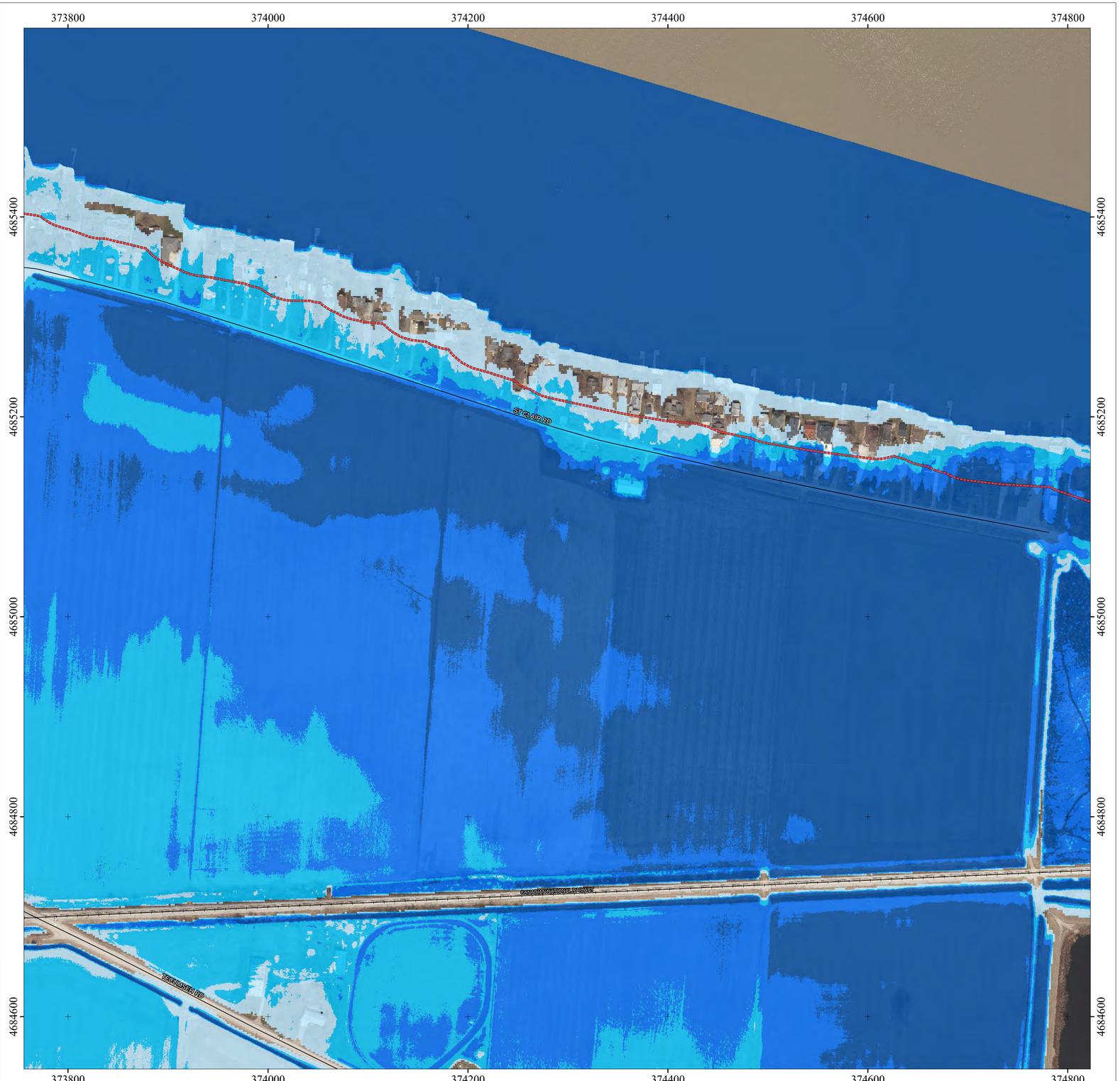

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MAP PUBLISHED APRIL 2021

Map 27 of 35

Municipality of Lakeshore Hazard Maps

Shoreline Management Plan

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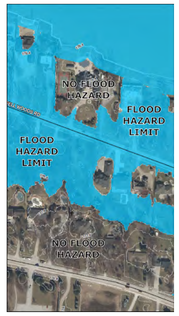

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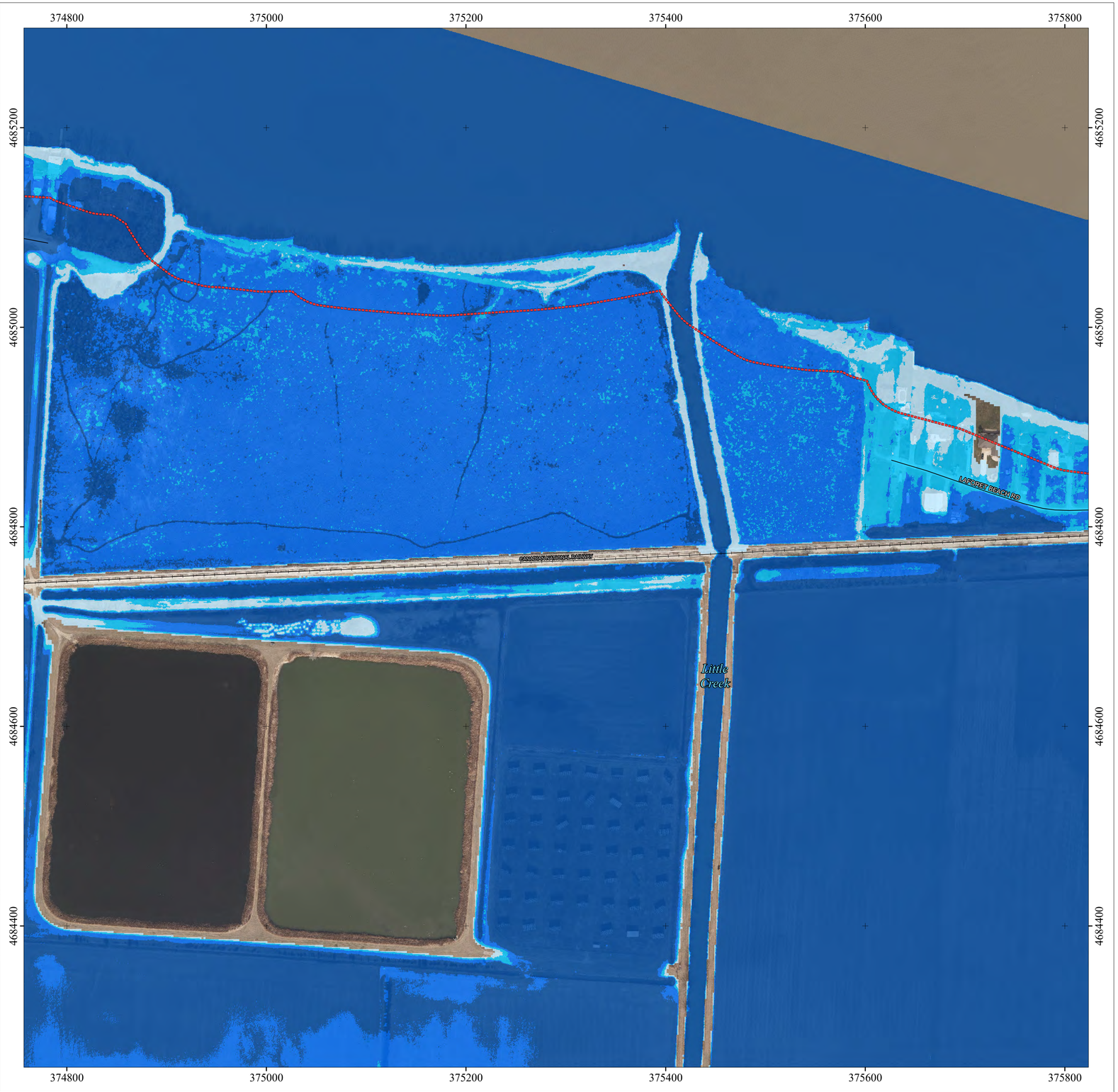

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MAP PUBLISHED APRIL 2021

Map 28 of 35

Municipality of Lakeshore Hazard Maps

Shoreline Management Plan

LEGEND:

- Erosion Hazard Limit
- Dynamic Beach Hazard Limit
- ERCA-LTVCA Boundary
- Municipal Boundary

100-year Flood Hazard - Depth of Flooding (m)

- 0 - 0.3 m (Up to ~1 ft)
- 0.31 - 0.6 m (Up to ~2 ft)
- 0.61 - 0.9 m (Up to ~3 ft)
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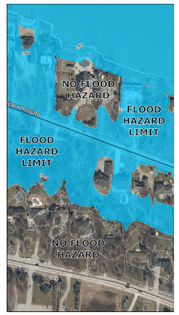

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0 50 100 200 m

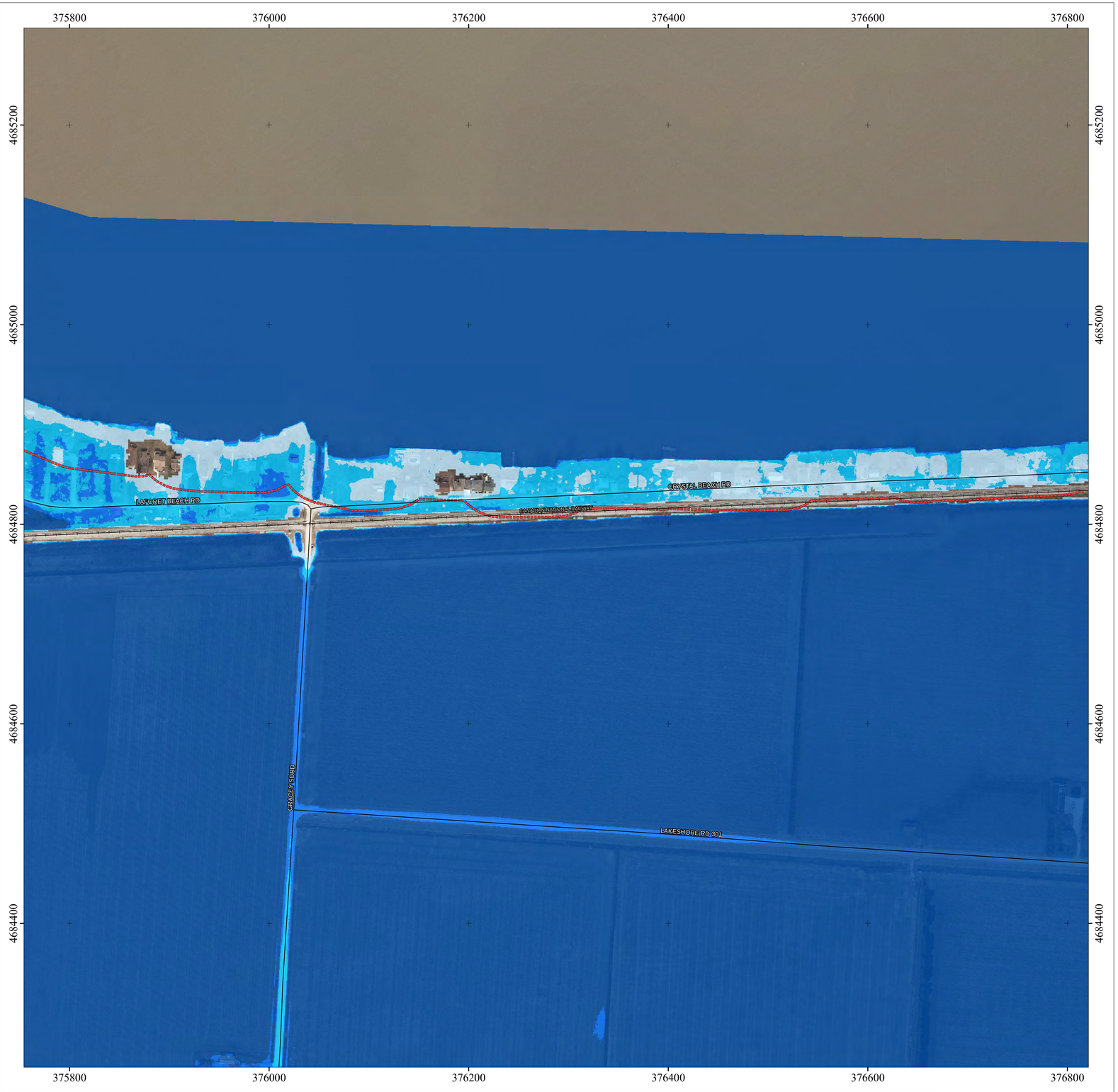
N W E S

PREPARED BY:

Zuzek inc. ONE WORLD

SJL ENGINEERING

Stantec



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MAP PUBLISHED APRIL 2021

Municipality of Lakeshore
Hazard Maps

SHORELINE MANAGEMENT PLAN

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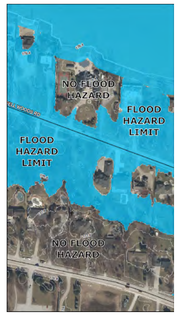

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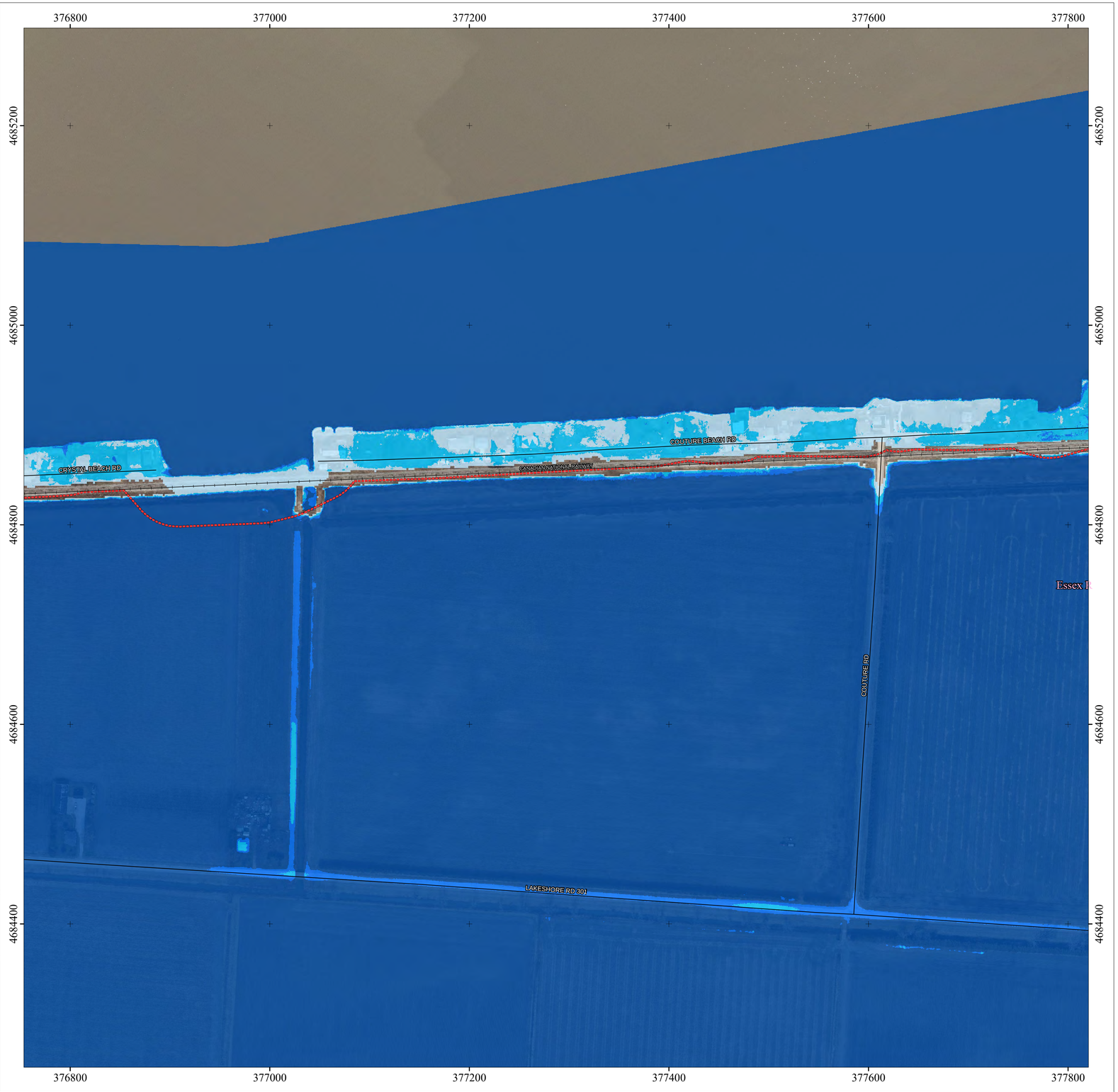

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Municipality of Lakeshore Hazard Maps

Shoreline Management Plan

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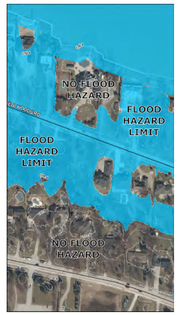

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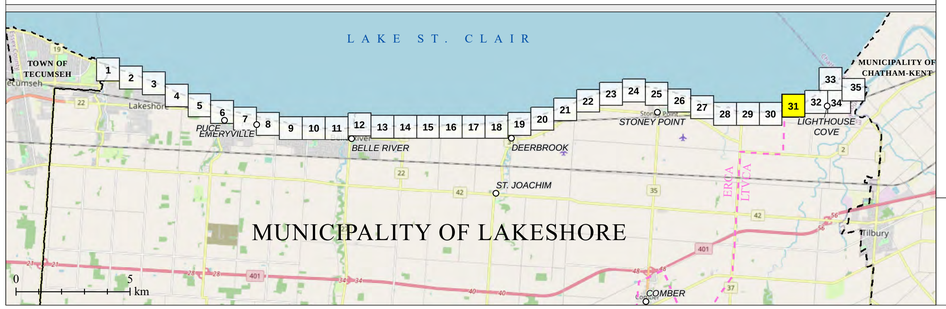
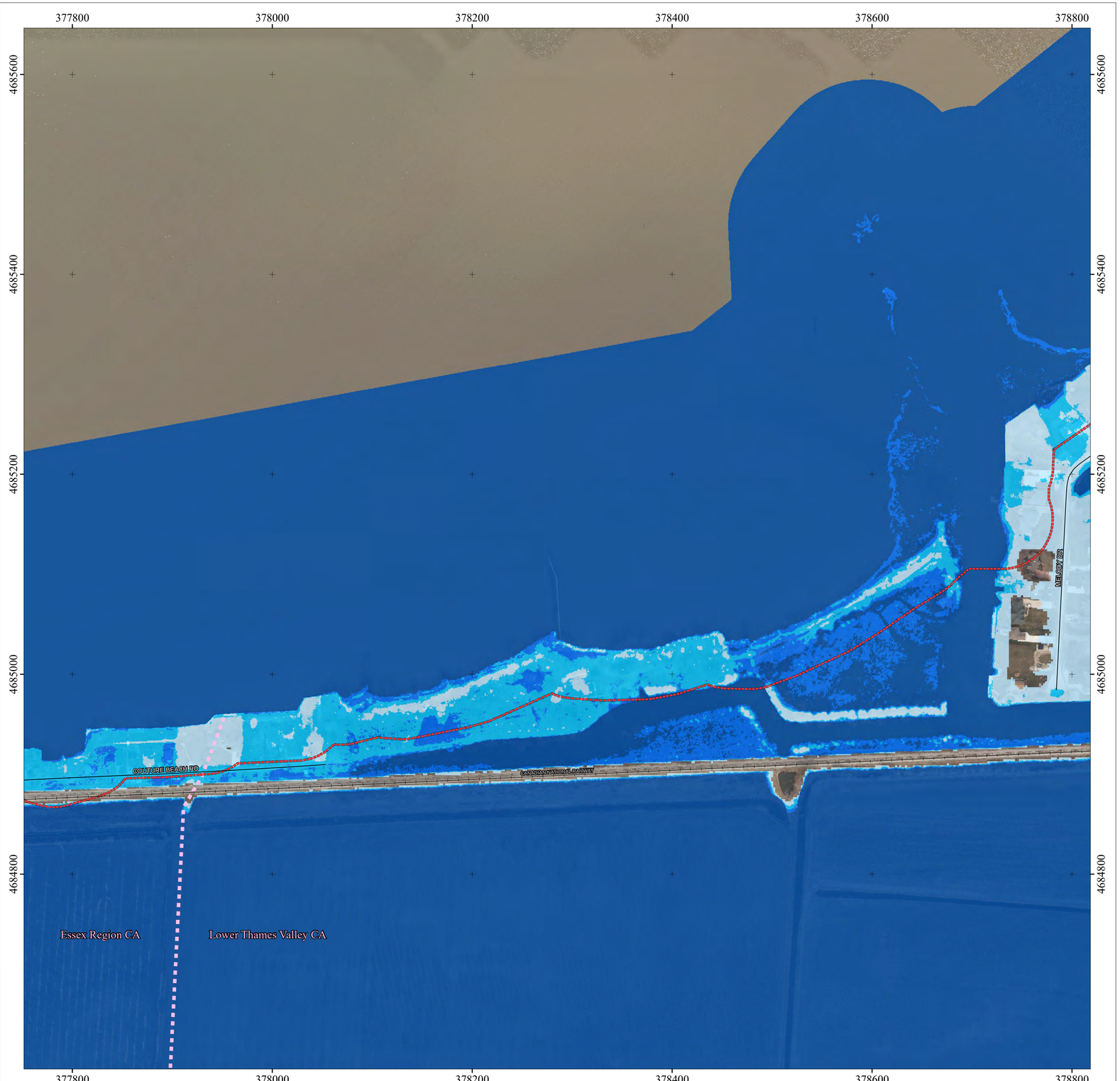
SJL ENGINEERING

Stantec





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MAP PUBLISHED APRIL 2021

Map 31 of 35

Municipality of Lakeshore Hazard Maps

Shoreline Management Plan

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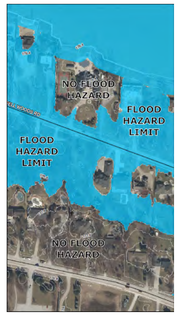

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0 50 100 200 m

N W E S

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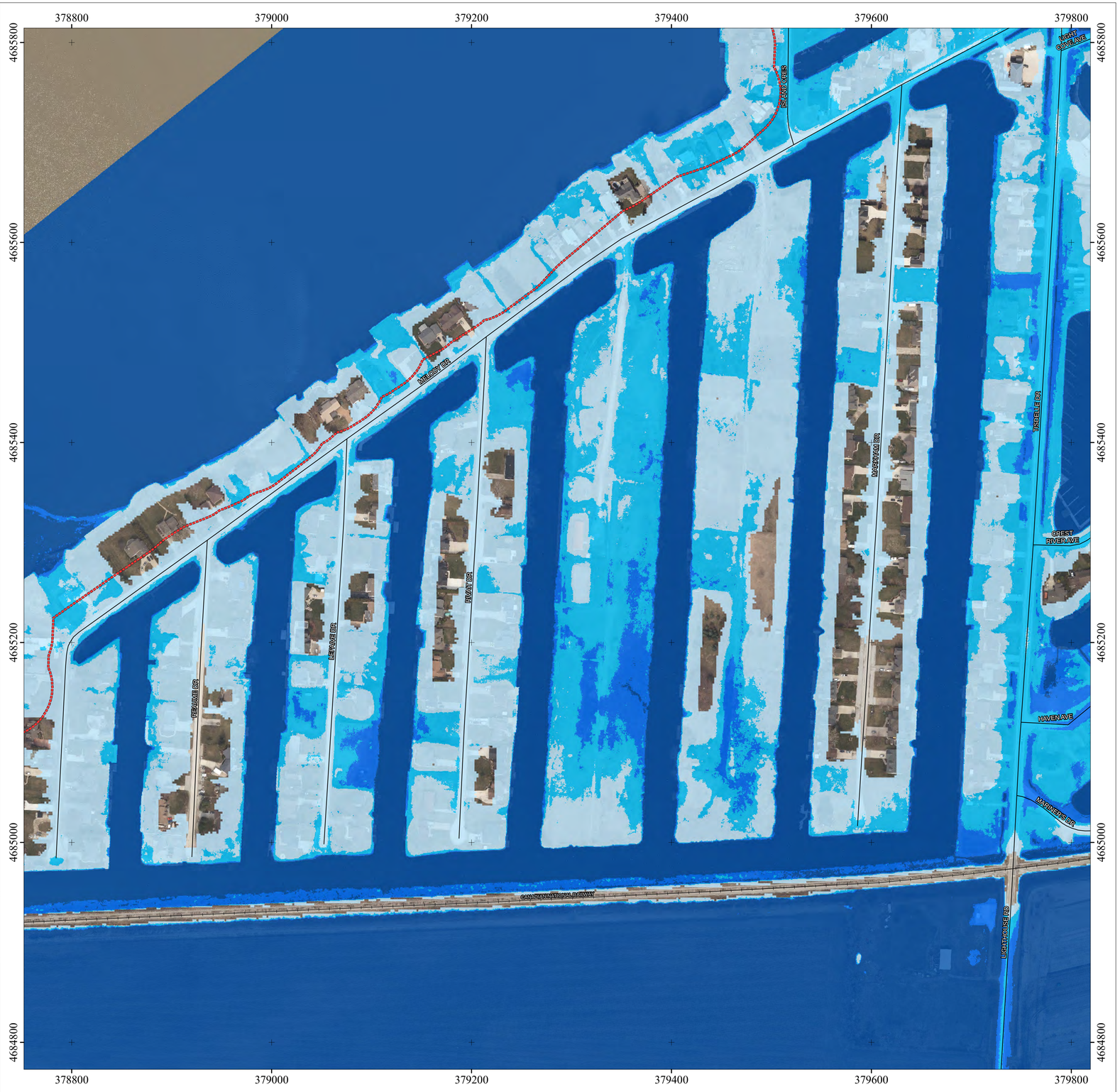
Zuzek inc. ONE WORLD

SJL ENGINEERING

Stantec



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MAP PUBLISHED APRIL 2021

MUNICIPALITY OF LAKESHORE HAZARD MAPS

SHORELINE MANAGEMENT PLAN

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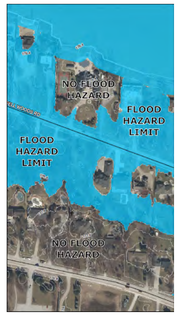

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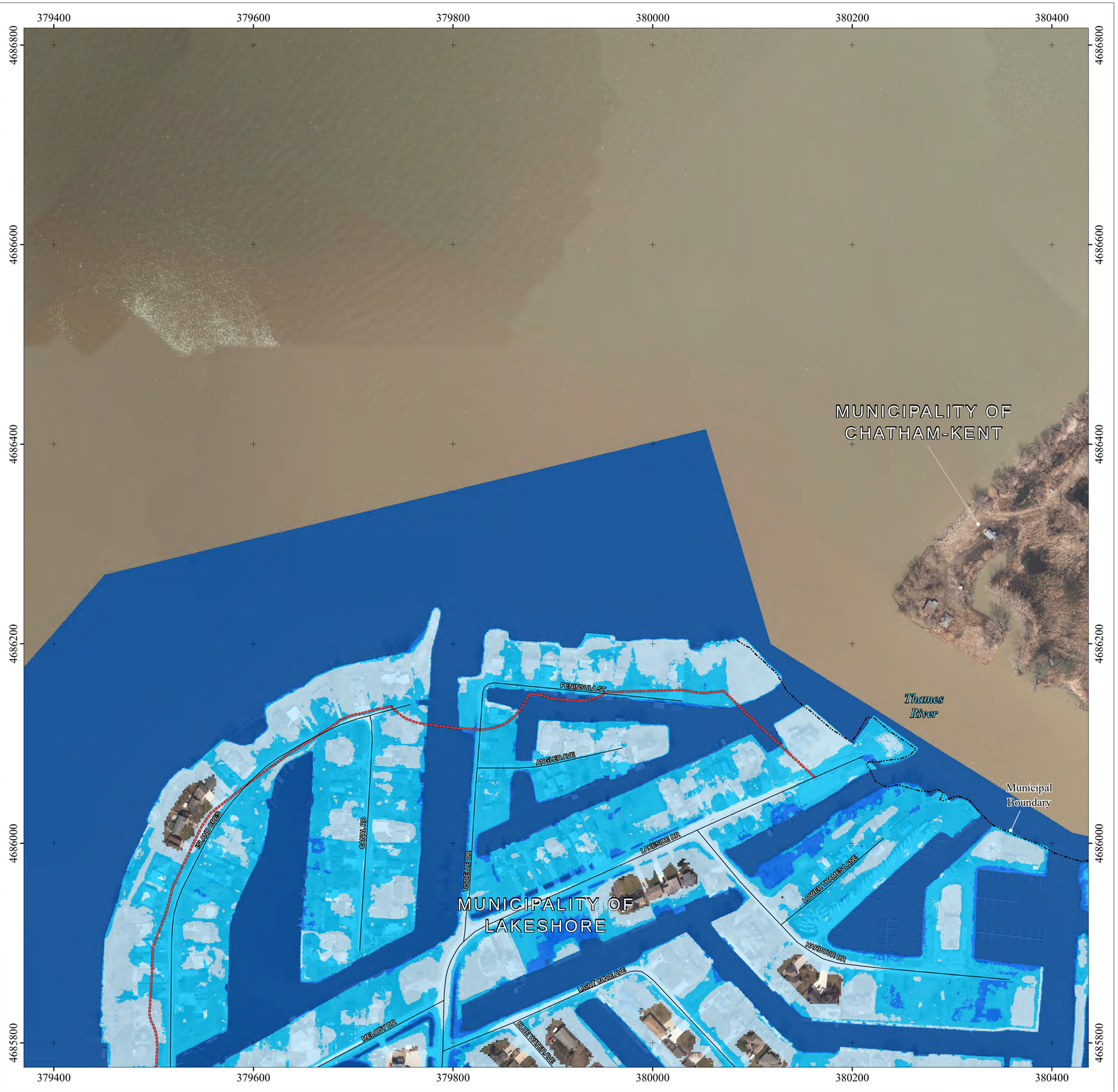

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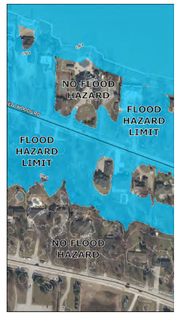

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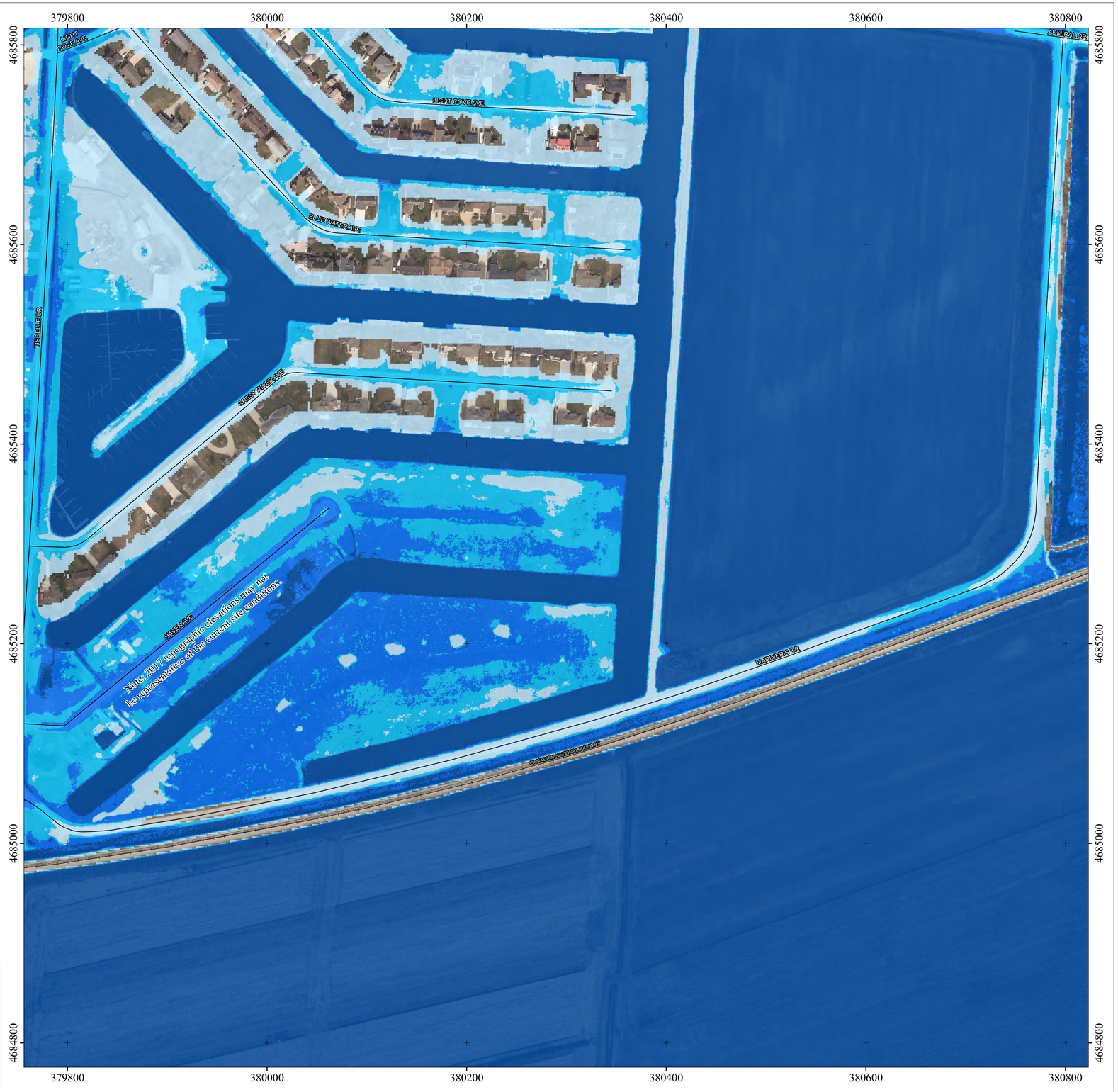

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- 0 - 0.3 m (Up to ~1 ft)
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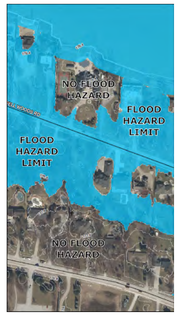
- 0.61 - 0.9 m (Up to ~3 ft)
- > 0.9 m (> ~3 ft)



INTERPRETATION OF THE HAZARD MAPS:

The hazard maps were prepared for the Municipality of Lakeshore Shoreline Management Plan. The hazard limits are not the official regulatory limits of the Essex Region Conservation Authority or Lower Thames Valley Conservation Authority. Please contact the Municipality of Lakeshore and Essex Region Conservation Authority or Lower Thames Valley Conservation Authority to discuss implications for proposed new development.

DEFINITIONS:

Depth of Flooding

The depth of flooding (m) is the difference in elevation between the 100 Year Combined Flood Level and the 2017 bare-earth LiDAR surface. The 100 year Combined Flood Level considers both static lake level and storm surge, having a combined probability of being equalled or exceeded during any year of 1% (i.e., probability, P =0.01). The 100 Year Combined Flood Level elevation for the Municipality of Lakeshore is as follows:

- *From the west boundary to Belle River (Maps 1 to 12):* +176.39 m IGLD85 (+175.86 m CGVD2013)
- *From Belle River to Stoney Point (Maps 13 to 25):* +176.33 m IGLD85 (+175.92 m CGVD2013)
- *From Stoney Point to Lighthouse Cove (Maps 25 to 35):* +176.57 m IGLD85 (+176.1 m CGVD2013)

Flood Hazard Limit

The Flood Hazard Limit is defined as the 100-Year Flood Level plus an allowance for wave runup and uprush. For the exposed shoreline, wave effects are calculated based on localized nearshore conditions and waves. Lake flooding in tributaries and drains estimated. Riverine floodplain not mapped. Refer to the Municipality of Lakeshore Shoreline Management Plan for additional details.

Erosion Hazard Limit

The erosion allowance was mapped from the approximate edge of existing shoreline protection based on measured historical recession rates established by Dillon (1976). West of Belle River, the recession rate was 0.3 m/year. East of Belle River to Stoney Point, the recession rate was 0.4 m/year. East of Stoney Point, the recession rate was 0.5 m/year.

Dynamic Beach Hazard Limit

The Dynamic Beach Hazard Limit is defined as the sum of the Flood Hazard plus 30 metres measured inland horizontally. If local conditions transition to other land uses (e.g., roads, parking lots, buildings), the inland extent is the limit of the beach material. The offshore limit is approximately the 2 m depth contour.

DATA SOURCES:

2020 Orthophotography provided by the County of Essex.

2017 LiDAR Digital Terrain Model obtained from the Ministry of Natural Resources and Forestry. Contains information licensed under the Open Government Licence – Ontario (land elevations modified post-2017 will not be reflected in this mapping).

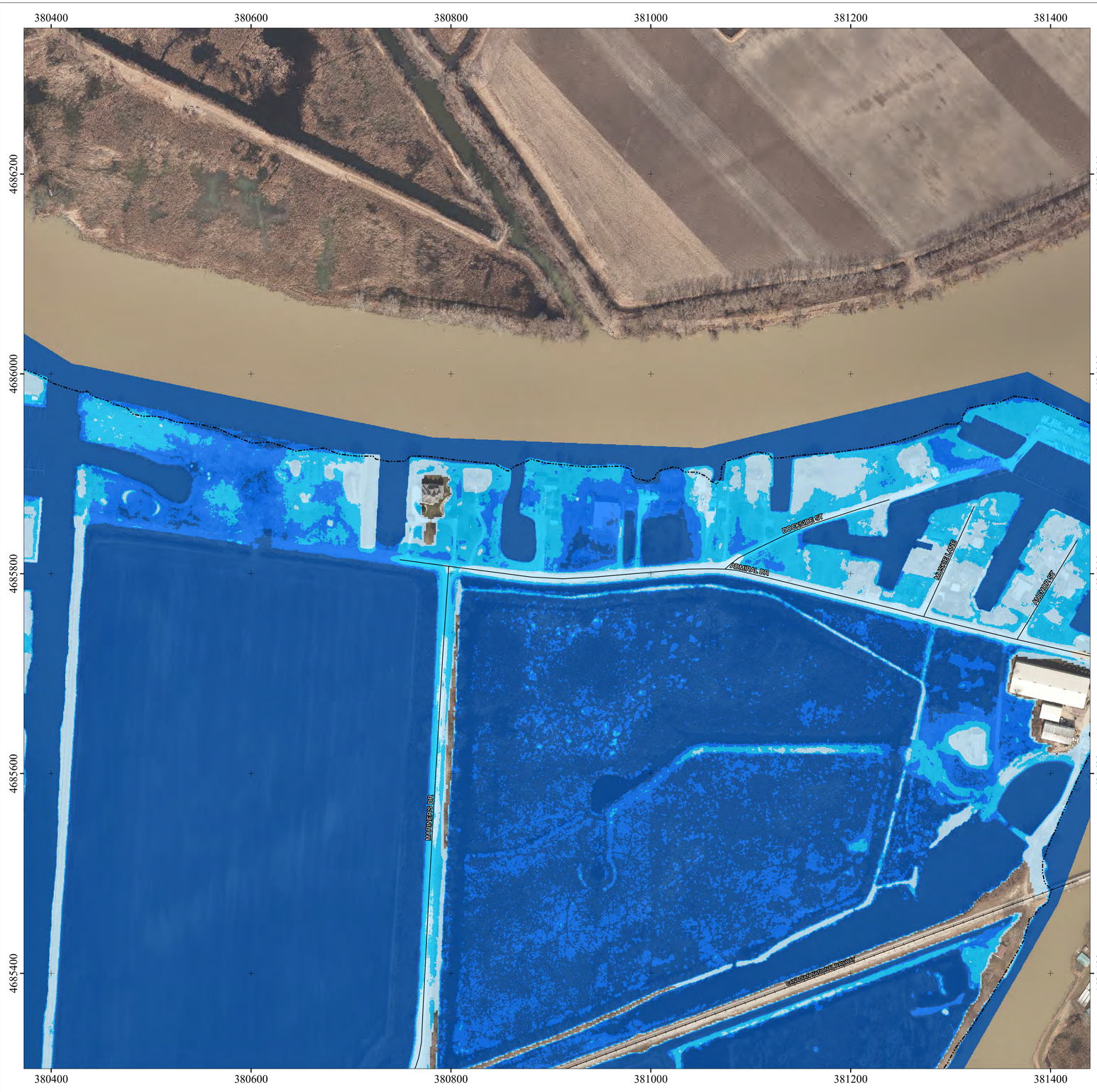
Inset Map: © OpenStreetMap contributors

Datums:
Horizontal: UTM 17N NAD1983, metres
Vertical: IGLD'85, metres

Datum Conversion:
IGLD'85 - CGVD2013 = 0.47 m (average)
To convert from IGLD'85 to CGVD2013, subtract 0.47 m.
IGLD'85 and CGVD1928 are equivalent (average difference of 0 m).

0 50 100 200 m

N W E S



PREPARED BY:

Zuzek inc. ONE WORLD

SJL ENGINEERING

Stantec

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Lakeshore

Mapping prepared by Zuzek Inc. for the Municipality of Lakeshore, with support from The County of Essex.

MAP PUBLISHED APRIL 2021

Map 35 of 35

Appendix E 3D Renderings of Flood Risk

Puce River, 175.2 m

Puce River, 176.39 m

Puce River, 176.77 m

Belle River, 175.2 m

Belle River, 176.39 m

Belle River, 176.77 m

Appendix F Shoreline Reach Summaries

Reach 1 – Pike Creek to Puce River

Local Conditions

- Reach Length = approximately 5.7 km.
- The reach extends from Pike Creek at the Tecumseh – Lakeshore boundary in the west to the Puce River.
- The low-lying shoreline properties are vulnerable to flooding, along with the development on the riverbanks.
- The roads in the western portion of the reach were designed to collect excess stormwater during heavy rainfall, which is evident in the flood maps.

Entrance to Pike Creek, Looking South

Flooded Keywall, Channel of Puce River Looking East

Depth of Road Flooding and Emergency Access

- Reach 1 features extensive road flooding, especially in the western portion of the reach near Pike Creek (depths of 0.6 to 0.9 m). Refer to Map 1 of 35 below.
- Depths will limit access for emergency vehicles during the 100-year flood.

Summary of Natural Hazards

- 100-year Erosion Rate (Stable Slope not included):

Start (UTM, Zone 17)	End (UTM, Zone 17)	100-year Erosion Rate (m/year)	Source
348268, 4687445	353601, 4685470	0.3	ERCA

- 100-year Lake Level:

Start (UTM, Zone 17)	End (UTM, Zone 17)	100-year Lake Level (m IGLD85')	100-year CC Lake Level (m IGLD85')
348268, 4687445	353601, 4685470	+176.39	+176.77

- Dynamic Beach(es):

Start (UTM, Zone 17)	End (UTM, Zone 17)	100-year Erosion Rate (m/year)	Dynamic Beach Name
n/a	n/a	n/a	n/a

- Nearshore Wave Climate for 100-year Wave Height:

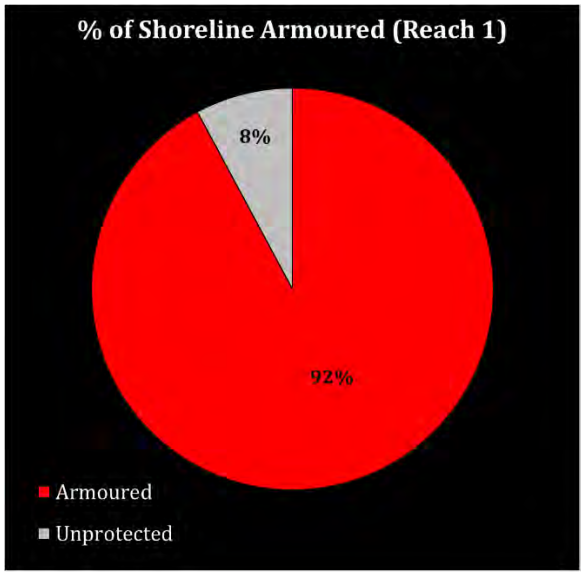
Water Depth (m)	Significant Wave Height, H_b (m)	Maximum Wave Height, H_{max} (m)	Deepwater Wave Height, H_o (m)	Wave Period, T_p (seconds)	Wave Length, L (m)
2.0	1.23	1.59	1.74	5.3	22.72
1.8	1.11	1.45	1.74	5.3	21.65
1.6	1.00	1.32	1.74	5.3	20.50
1.4	0.90	1.19	1.74	5.3	19.26
1.2	0.79	1.08	1.74	5.3	17.90
1.0	0.69	0.95	1.74	5.3	16.40

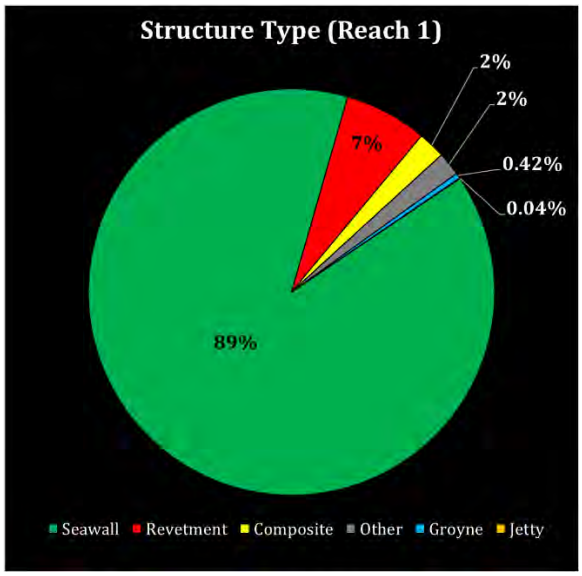
Flooding and Erosion Threats

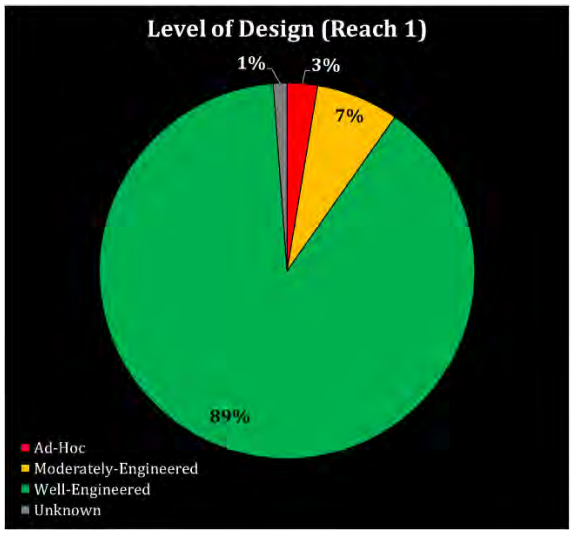
- Flooding along the lakeshore due to low-crested shore protection structures and low-lying interior land.
- The development in Pike Creek and the Puce River is also vulnerable to lake flooding during the 100-year lake level.
- Roads are extensive flooded adjacent to Pike Creek during the 100-year flood level which will limit ingress and egress for residents and emergency service vehicles.
- Adjacent to the Puce River, lake flooding over seawalls and the banks of the river will propagate inland and south of the Canadian National Railway. The lake flood extends south over large areas of agricultural land.
- This analysis does not consider riverine flooding from rainfall events, only coastal flooding.

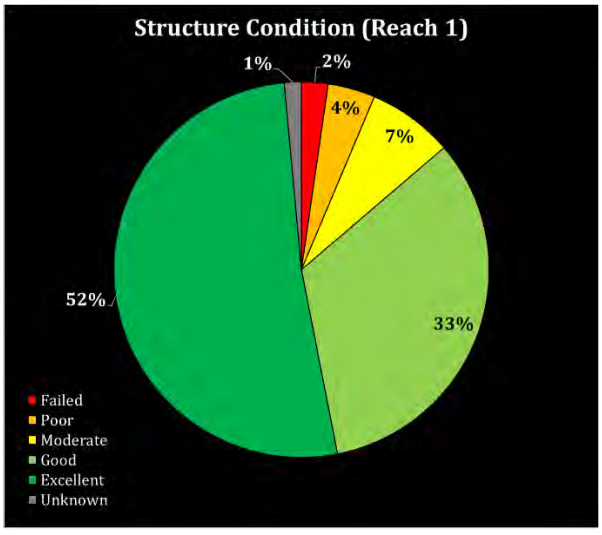
Existing Shoreline Protection Structures

- The lake shoreline and riverbanks of Reach #1 are 92% armoured with shoreline protection.
- Majority of the structures are vertical steel and concrete seawalls (89%). Armour stone revetments are also present (7%).
- Most of the structures are well-engineered (89%) but many feature a low crest (top) elevation which results in wave overtopping and coastal flooding.
- Structurally, 85% of the shore protection is in good to excellent condition.



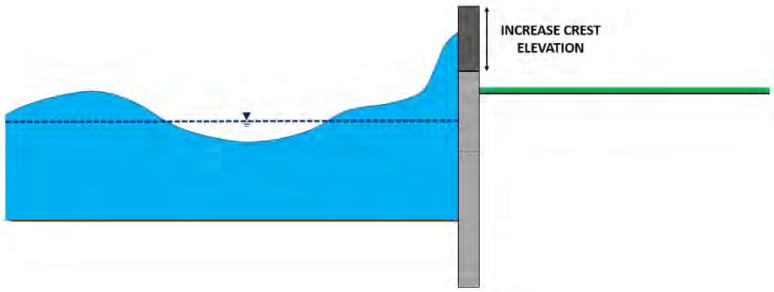




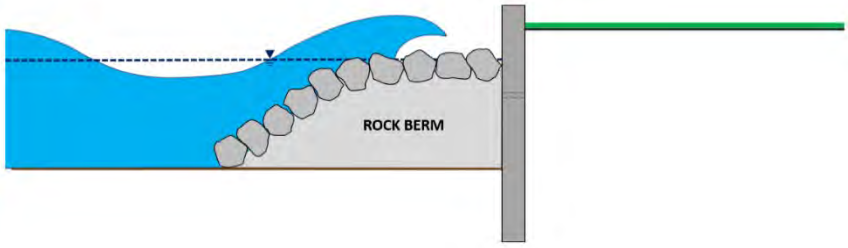


Recommendations for Shoreline Protection Structures

- Future studies should establish standard engineering design criteria for shoreline protection structures along the lake and riverbanks to reduce flood risk.
- Raising the crest of existing shoreline protection structures is an effective mitigation strategy for wave overtopping and interior flooding. Refer to the schematic diagram below.



- Another common mitigation approach is the construction of a rock berm at the base of existing vertical walls to dissipate incoming wave energy before it leads to wave overtopping at seawalls. Refer to the schematic diagram below.



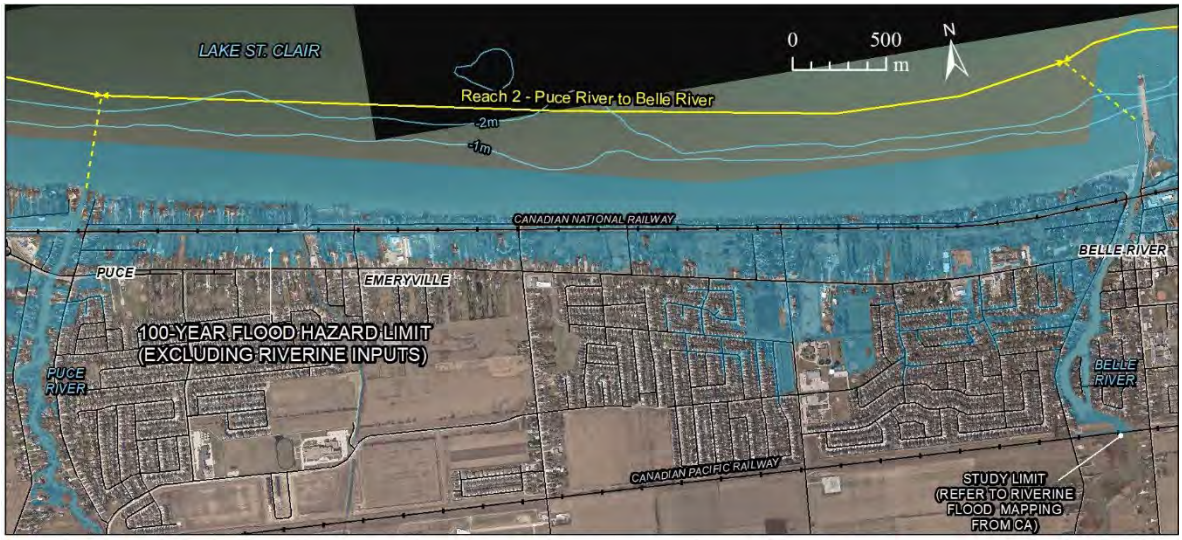
- Unprotected properties should be upgraded with engineered berms, natural vegetation buffers, and/or engineered shore protection to mitigate wave runup and interior flooding. See example of unprotected property in the adjacent image.

Shoreline Management Recommendations

- Adopt standard engineering criteria for shoreline protection structures and flood mitigation. Increasing flood resilience will require a continuous mitigation strategy for the entire reach.
- A reach-scale program to flood proof existing buildings is required.
- Further assessment of emergency vehicle access during the 100-year flood and the 100-year climate change flood is required, as water depths are significant is some areas of Reach 1 (e.g., 0.6 to 0.9 m). An emergency response plan is needed if vehicle access is not possible in these areas.
- Future residential or commercial development should not proceed in Reach 1 unless emergency vehicle access is attainable during the 100-year flood and ideally during the 100-year climate change flood.

Use Disclaimer

Reach 2 – Puce River to Belle River



Local Conditions

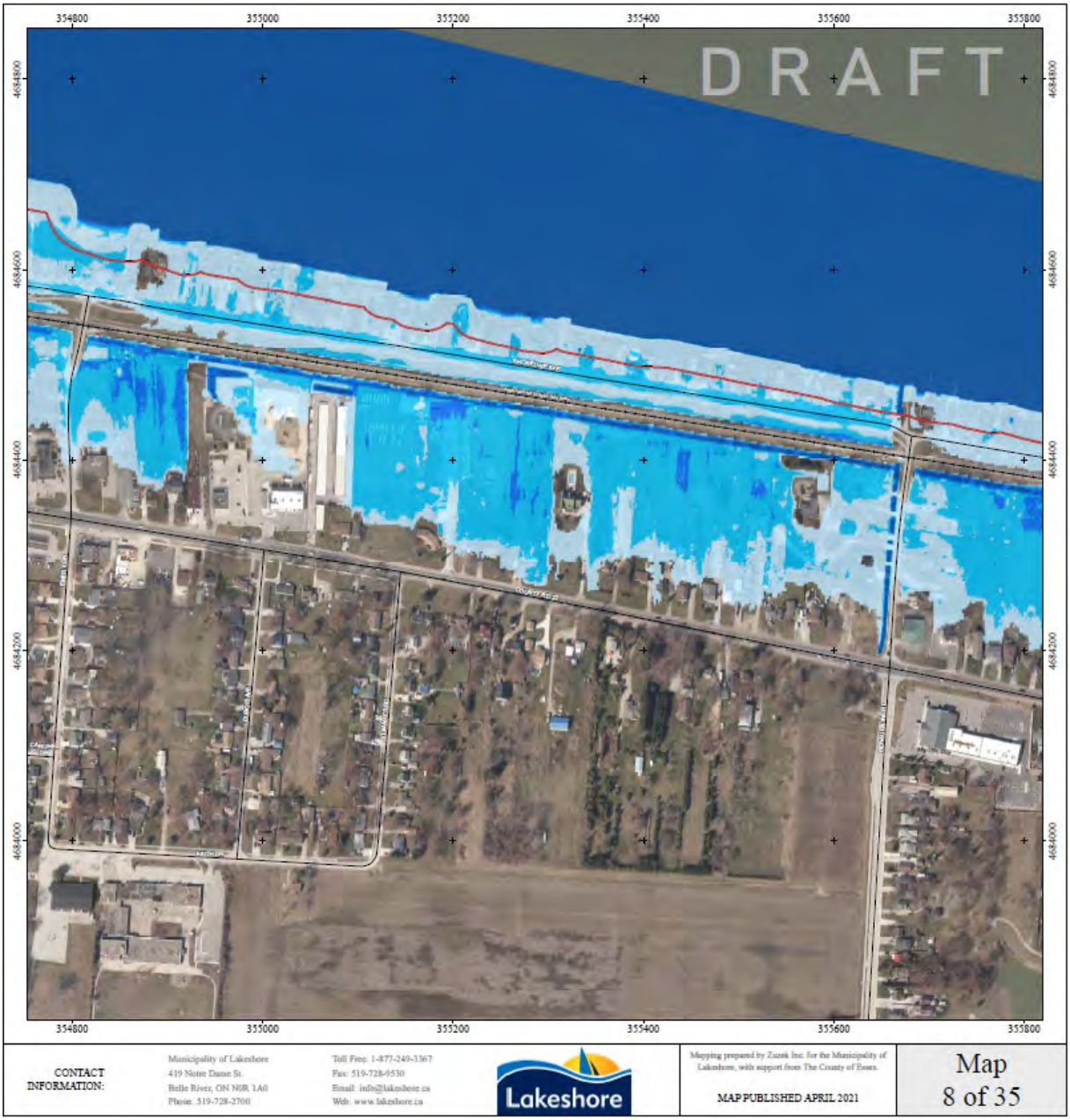
- Reach Length = approximately 5.6 km.
- The reach extends from the east banks of the Puce River to the west bank Belle River.
- The shoreline and riverbanks feature dense residential development.
- The waters edge features a wide variety of conditions, from natural beaches to vertical walls, sloping rock structures, and boat docks. .

Entrance to Puce River Looking South

Flood Prone Beach Shoreline

Depth of Road Flooding and Emergency Access

- Entire neighbourhoods north of Canadian National Railway would be under water during the 100-year flood, as seen in Map 8 of 35 below.
- Depth of road flooding is 0.3 to 0.6 m in some parts of Reach 2.



Summary of Natural Hazards

- 100-year Erosion Rate (Stable Slope not included):

Start (UTM, Zone 17)	End (UTM, Zone 17)	100-year Erosion Rate (m/year)	Source
353601, 4685470	358964, 4684139	0.3	ERCA

- 100-year Lake Level:

Start (UTM, Zone 17)	End (UTM, Zone 17)	100-year Lake Level (m IGLD85')	100-year CC Lake Level (m IGLD85')
353601, 4685470	358964, 4684139	176.39	176.77

- Dynamic Beach(es):

Start (UTM, Zone 17)	End (UTM, Zone 17)	100-year Erosion Rate (m/year)	Dynamic Beach Name
358418, 4684143	358964, 4684139	n/a	Lakeview Park West

- Nearshore Wave Climate for 100-year Wave Height:

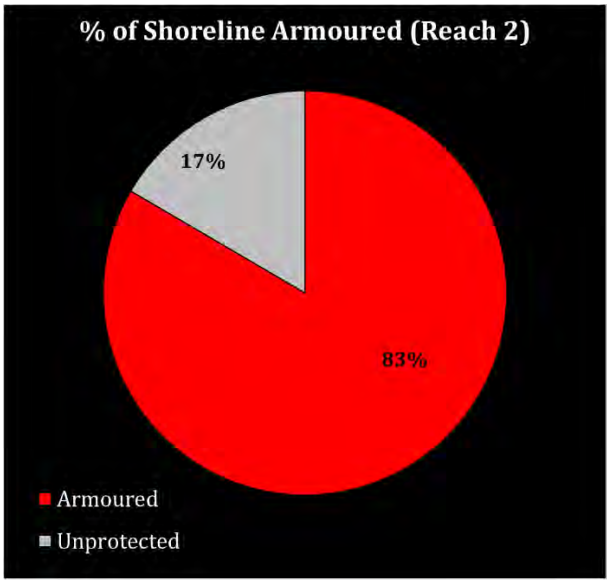
Water Depth (m)	Significant Wave Height, H_b (m)	Maximum Wave Height, H_{max} (m)	Deepwater Wave Height, H_o (m)	Wave Period, T_p (seconds)	Wave Length, L (m)
2.0	1.23	1.59	1.74	5.3	22.72
1.8	1.11	1.45	1.74	5.3	21.65
1.6	1.00	1.32	1.74	5.3	20.50
1.4	0.90	1.19	1.74	5.3	19.26
1.2	0.79	1.08	1.74	5.3	17.90
1.0	0.69	0.95	1.74	5.3	16.40

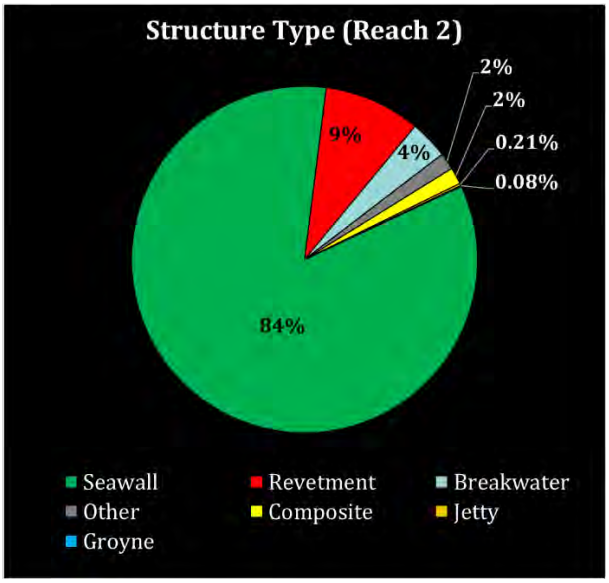
Summary of Flooding and Erosion Threats

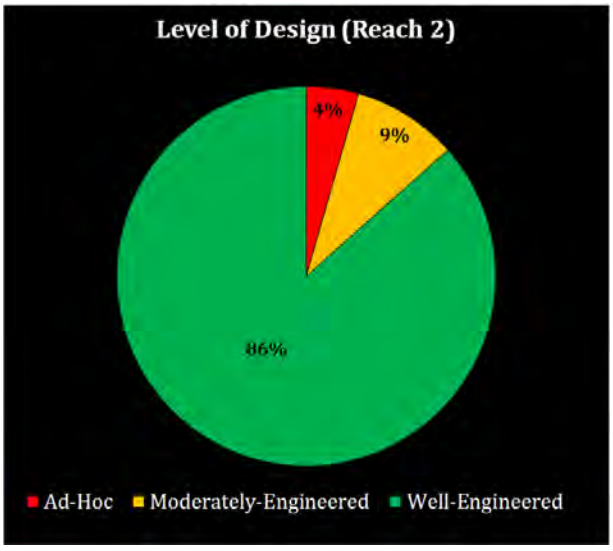
- Extensive lake flooding in Reach 2, between the shoreline and CNR tracks for the 100-year lake level. South of the CNR tracks, there is limited flood risk to buildings, as their foundations are generally raised.
- Flooding along the lake is due to low-crested shore protection structures, sandy beach areas without shore protection, and low-lying interior land that acts as a flood pathway.
- Unprotected properties or lots with ad-hoc shore protection are vulnerable to shoreline erosion.
- Road flooding is extensive during the 100-year lake level, which will inhibit emergency ingress and egress for residents and emergency vehicles.
- There is extensive riverbank flooding in the Puce River and Belle River during the 100-year lake level due to low lying land and low crested shore protection.
- This flood summary does not consider riverine flooding from rainfall events.

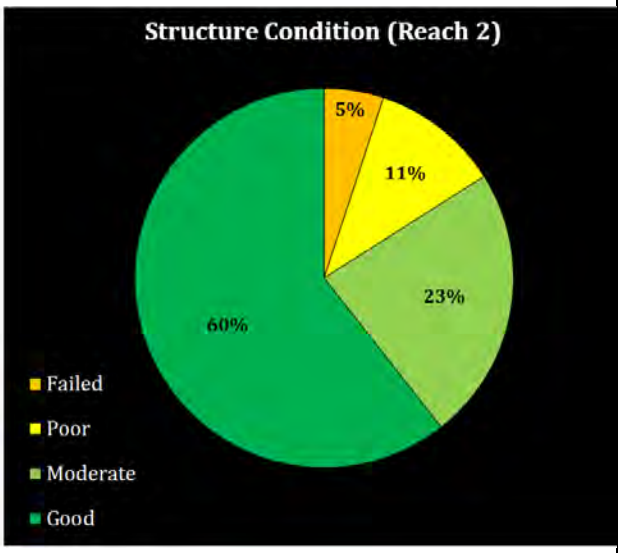
Existing Shoreline Protection Structures

- The lake shoreline and riverbanks of Reach #2 are 83% armoured with shoreline protection.
- The majority of the structures are vertical steel and concrete seawalls (84%). Armour stone revetments are also present (9%).
- Most of the structures are well-engineered (86%) structurally but many feature a low crest (top) elevation which leads to wave overtopping and flooding.
- 83% of the protection is in good to excellent structural condition.



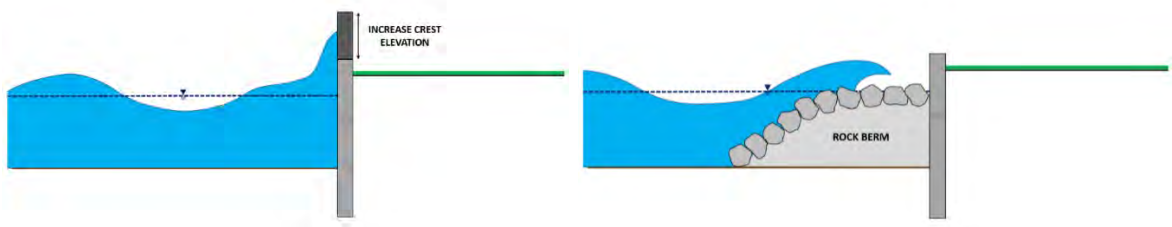




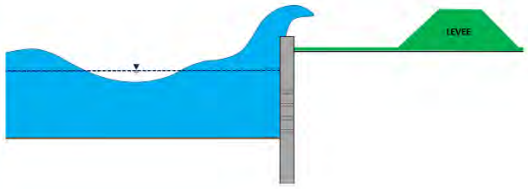


Recommendations for Shoreline Protection Structures

- Future studies should establish standard engineering design criteria for shoreline protection structures along the lake and riverbanks to reduce flood risk.
- Raising the crest elevation of existing vertical structures is an effective mitigation strategy for wave overtopping and interior flooding. Refer to the schematic diagram below. Construction of rock berms in front of vertical walls is another strategy to reduce wave overtopping.



- Natural beach shorelines provide desirable access to the lake but are low lying and contribute significantly to the flood risk in Lakeshore. Berms, dikes, or levees could be constructed landward of the sand beaches to reduce flood risk.



- Unprotected properties should be protected with engineered shore protection to reduce risk erosion and flooding hazards, including propagation of coastal flooding inland. Options include berms or levees, removable flood barriers, revetments, and seawalls.

Shoreline Management Recommendations

- Adopt standard engineering criteria for shoreline protection structures and flood mitigation in Reach 2. Increasing flood resilience will require continuous mitigation across Reach 2 with a community scale project.
- Further assessment of emergency vehicle access during the 100-year flood and the 100-year climate change flood is required, as the depth of water over roads is 0.3 to 0.6 m in many locations. Safe ingress and egress are a requirement of the 2020 Provincial Policy Statement (Section 3.1.2 c) for new development.
- Future residential development should not proceed on hazardous lands in Reach 2 unless flood risk is mitigated and emergency vehicle access is

attainable during the 100-year flood and the 100-year climate change flood, as per Section 3.1.2 of the Provincial Policy Statement 2020.

Use Disclaimer

Reach 3 – Belle River to Ruscom River

Local Conditions

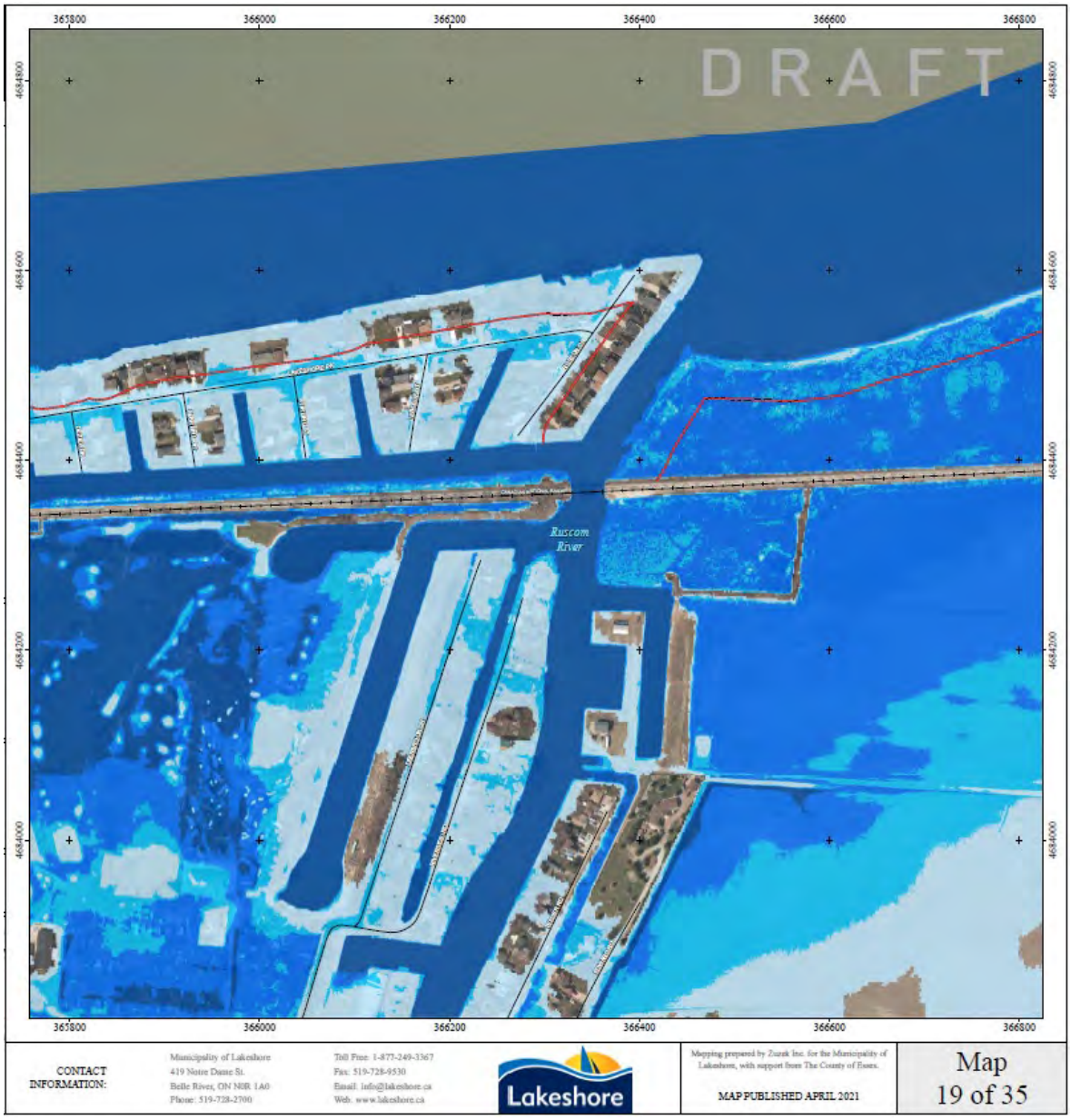
- Reach Length = approximately 7.5 km.
- The reach extends from east bank of Belle River and Marina to the west bank of the Ruscom River.
- The shoreline features extensive residential development with limited undeveloped or vacant lots.
- The majority of the shoreline is armoured and features numerous private boat docks.

Belle River Marina Looking South

Ruscom Rivermouth Looking South

Depth of Road Flooding and Emergency Access

- The majority of the road network north of the CNR tracks would be flooded during the 100-year lake level, especially between Belle River and Duck Creek and east of Moison Creek to the Ruscom River in Reach 3.
- The depth of road flooding is generally between 0.01 and 0.3 m, with depths in the 0.31 to 0.6 m near the Ruscom River. See Map 19 below.



Summary of Natural Hazards

- 100-year Erosion Rate (Stable Slope not included):

Start (UTM, Zone 17)	End (UTM, Zone 17)	100-year Erosion Rate (m/year)	Source
359221, 4684182	366405, 4685105	0.4	ERCA

- 100-year Lake Level:

Start (UTM, Zone 17)	End (UTM, Zone 17)	100-year Lake Level (m IGLD85')	100-year CC Lake Level (m IGLD85')
359221, 4684182	366405, 4685105	176.33	176.71

- Dynamic Beach(es):

Start (UTM, Zone 17)	End (UTM, Zone 17)	100-year Erosion Rate (m/year)	Dynamic Beach Name
358689, 4684813	359345, 4684204	n/a	Belle River East Fillet

- Nearshore Wave Climate for 100-year Wave Height:

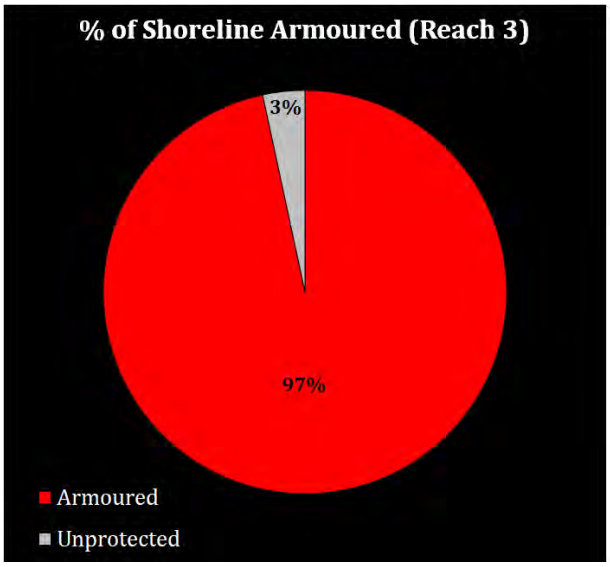
Water Depth (m)	Significant Wave Height, H_b (m)	Maximum Wave Height, H_{max} (m)	Deepwater Wave Height, H_o (m)	Wave Period, T_p (seconds)	Wave Length, L (m)
2.0	1.23	1.59	1.74	5.3	22.72
1.8	1.11	1.45	1.74	5.3	21.65
1.6	1.00	1.32	1.74	5.3	20.50
1.4	0.90	1.19	1.74	5.3	19.26
1.2	0.79	1.08	1.74	5.3	17.90
1.0	0.69	0.95	1.74	5.3	16.40

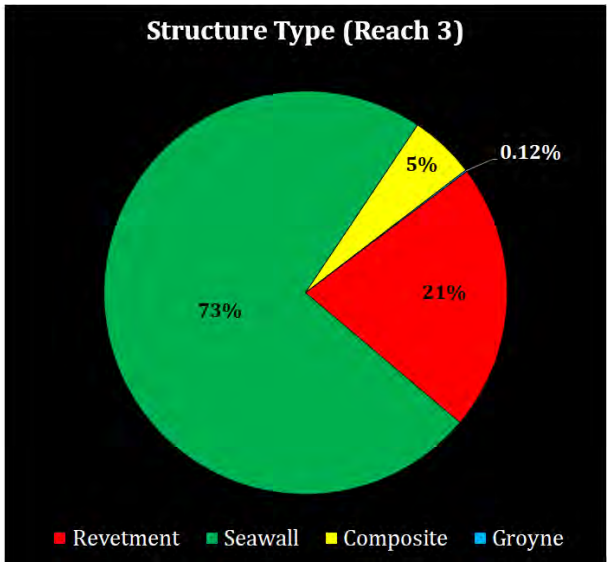
Summary of Flooding and Erosion Threats

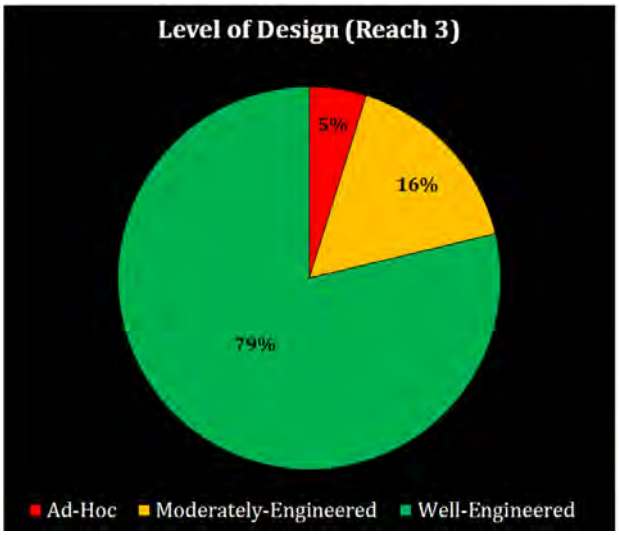
- For the first 1 km east of Belle River, the flood hazard is primarily limited to road flooding, with minimal wet building foundations.
- West of Duck Creek, there is significant road flooding south of the CNR tracks for the 100-year lake level. East of Duck Creek, there would be road and building flooding for the 100-year lake level.
- From the Moison River to Ruscom River, there is extensive lakeshore and interior flooding south of the CNR tracks for the 100-year lake level. Buildings, roadways, and agricultural fields would be inundated.
- The majority of the Rochester Place Golf Course would be under water for the 100-year lake level, with the exception of the Club House.
- This analysis does not consider riverine flooding from rainfall events, only coastal flooding.

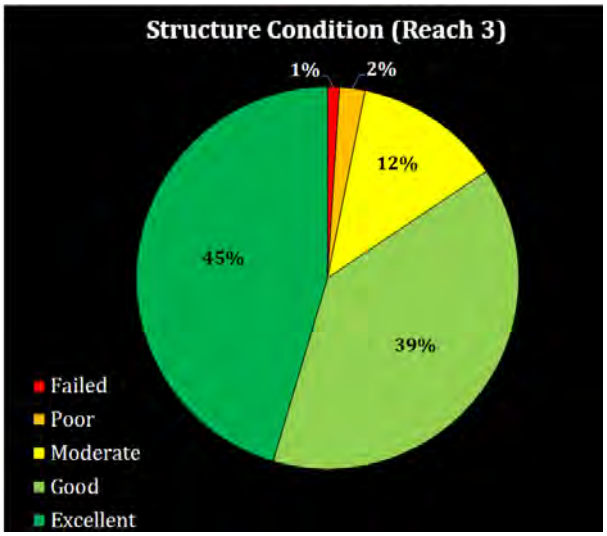
Existing Shoreline Protection Structures

- The lake shoreline and riverbanks of Reach #3 are 97% armoured with shoreline protection, which is the highest percentage of any Lakeshore reach.
- Majority of the structures are vertical steel and concrete seawalls (73%), but armour stone revetments are also present (21%).
- A large percentage of the structures are well-engineered (79%), but many feature a low crest (top) elevation which contributes to coastal flooding.
- 84% of the shore protection is in good to excellent condition structurally but many should have been constructed with a higher crest elevation.



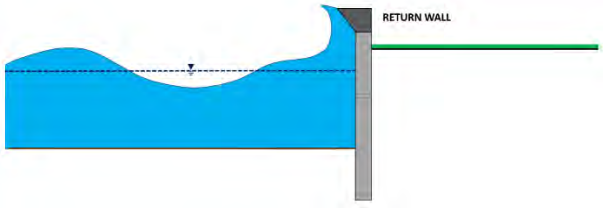


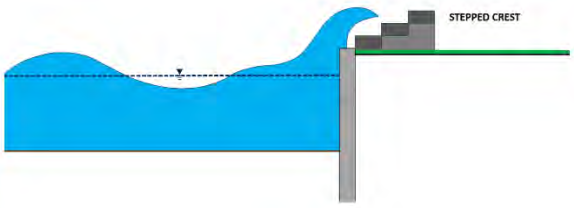




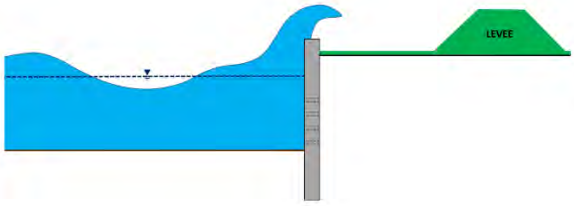
Recommendations for Shoreline Protection Structures

- Future studies should establish standard engineering design criteria for shoreline protection structures along the lake and riverbanks to reduce wave overtopping volumes and wave uprush, which contributes to lakeshore and interior flooding.
- Raising the crest of existing shoreline protection structures is an effective mitigation strategy to reduce wave overtopping and interior flooding. Other options include the addition of a return wall or new stepped crest, as seen in the diagrams below.





- Another approaches to reduce wave overtopping is the construction of a berm or levee landwards of the shore protection to prohibit the flood from propagating inland. Schematic diagram and an example of an existing berm from Reach 3 are provided below.



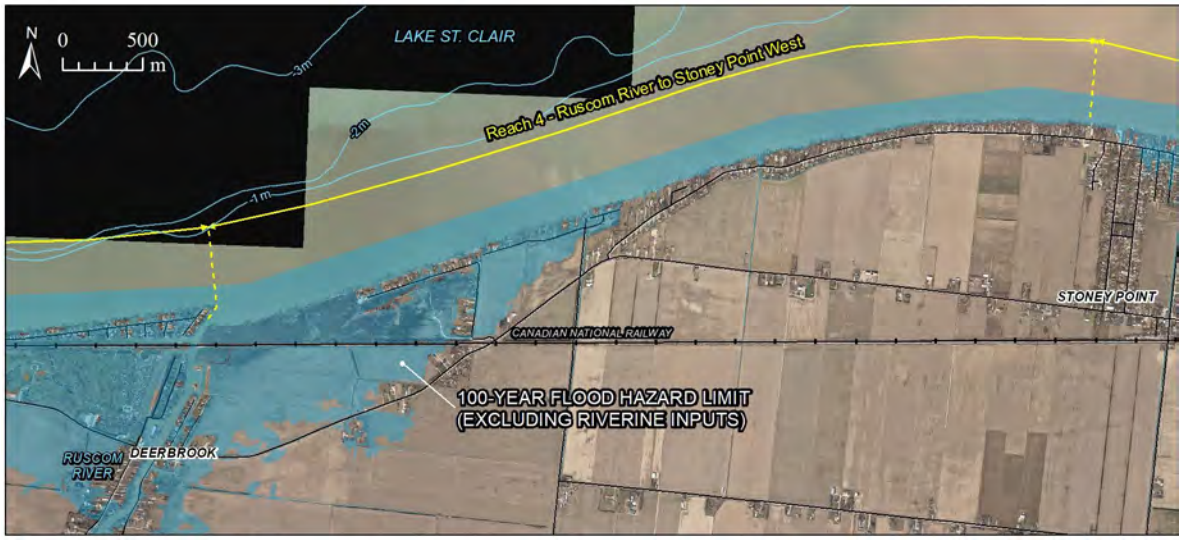
- Failed shore protection (see adjacent picture) should be repaired to provide a continuous barrier to coastal flooding in Reach 3. Repairs can use conventional engineering methods such as seawalls or revetments, or integrate hybrid approaches such as berms, living shoreline, and other nature-based solutions.

Shoreline Management Recommendations

- Adopt standard engineering criteria for shoreline protection structures and flood mitigation. Pursue a community scale solution for Reach 3 to increase resilience to coastal flooding with continuous shoreline protection/mitigation.
- Evaluate options for a community-scale flood proofing plan for buildings.
- Further assessment of emergency vehicle access during the 100-year flood and the 100-year climate change flood is required, as the depth of flooding over roads is up to 0.3 to 0.6 m in some locations. Safe ingress and egress are a requirement of the 2020 Provincial Policy Statement (Section 3.1.2 c) for all new development applications.
- Future development should not proceed on hazardous lands in Reach 3 unless the flood risk is mitigated and emergency vehicle access is attainable during the 100-year flood, as per Section 3.1.2 of the Provincial Policy Statement 2020.

Use Disclaimer

Reach 4 – Ruscom River to Stoney Point West



Local Conditions

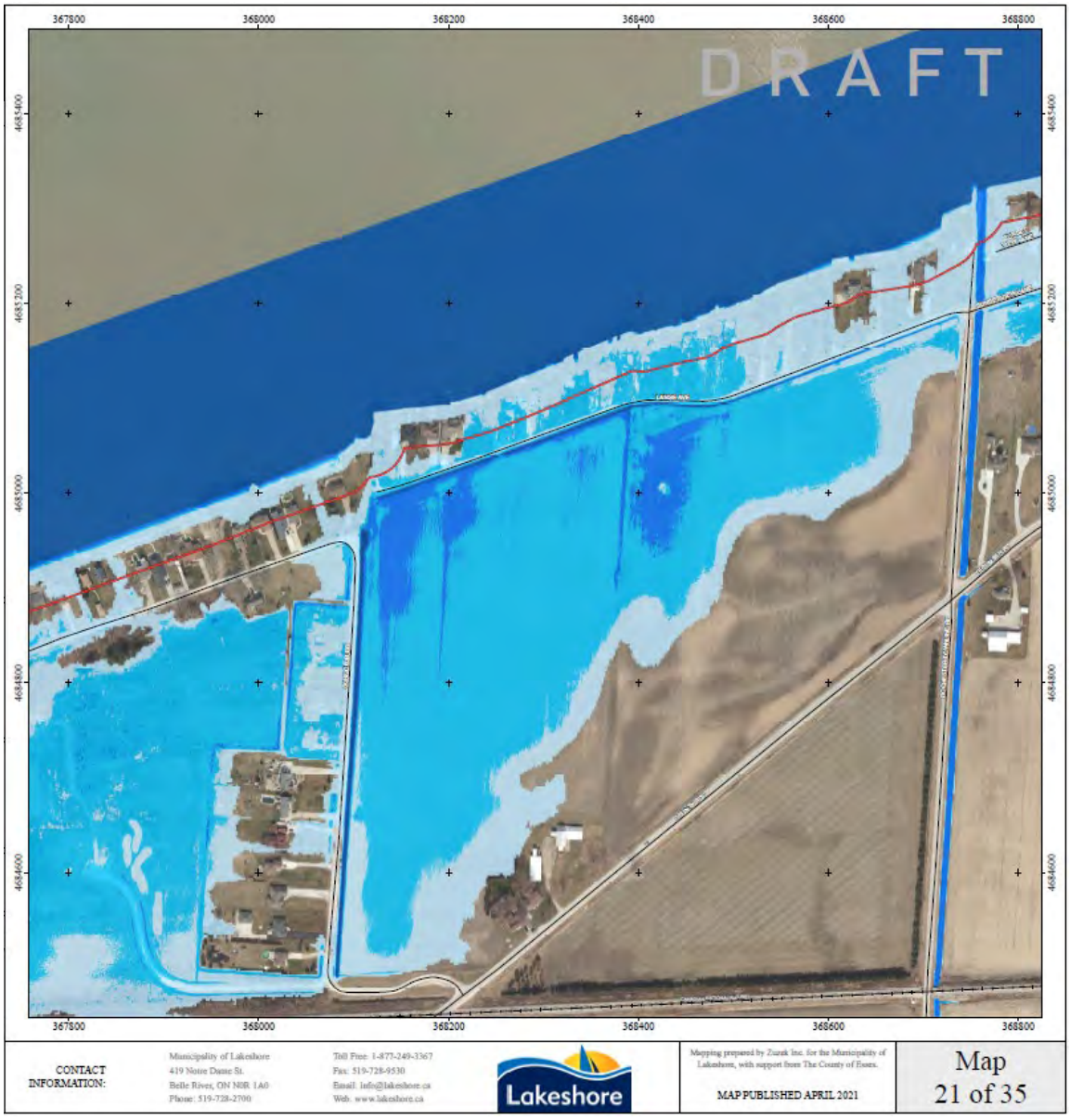
- Reach Length = approximately 5.6 km.
- The reach includes the eastern shore of the Ruscom River to the intersection of St. Clair Road and Columbus Drive.
- The land elevations are generally higher in Reach 4 than surrounding reaches and consequently there is less flood risk compared to other reaches.
- A large natural area, Ruscom Shores Conservation Area, is located at the western limit of the reach adjacent to the Ruscom Rivermouth. The shoreline has been eroding since 1975 and the marsh has filled in with dense emergent vegetation (potentially the invasive reed Phragmites).

Eastern Bank of Ruscom River Mouth

Beach Shoreline with Sand Bags

Depth of Road Flooding and Emergency Access

- Lange Avenue and Surf Club Drive in Reach 4 is inundated during the 100-year lake level with water depths ranging from 0.01 to 0.3 m, with localized areas where the flood depth exceeds 0.3 m (such as the west end of Surf Club Drive). See Map 21 of 35 below.
- The remainder of the roads in Reach 4 are higher and not flood prone.



Summary of Natural Hazards

- 100-year Erosion Rate (Stable Slope not included):

Start (UTM, Zone 17)	End (UTM, Zone 17)	100-year Erosion Rate (m/year)	Source
366414, 4684380	371883, 4686480	0.4	ERCA

- 100-year Lake Level:

Start (UTM, Zone 17)	End (UTM, Zone 17)	100-year Lake Level (m IGLD85')	100-year CC Lake Level (m IGLD85')
366414, 4684380	371883, 4686480	+176.33	+176.71

- Dynamic Beach(es):

Start (UTM, Zone 17)	End (UTM, Zone 17)	100-year Erosion Rate (m/year)	Dynamic Beach Name
n/a	n/a	n/a	n/a

- Nearshore Wave Climate for 100-year Wave Height:

Water Depth (m)	Significant Wave Height, H_b (m)	Maximum Wave Height, H_{max} (m)	Deepwater Wave Height, H_o (m)	Wave Period, T_p (seconds)	Wave Length, L (m)
2.0	1.23	1.59	1.74	5.3	22.72
1.8	1.11	1.45	1.74	5.3	21.65
1.6	1.00	1.32	1.74	5.3	20.50
1.4	0.90	1.19	1.74	5.3	19.26
1.2	0.79	1.08	1.74	5.3	17.90
1.0	0.69	0.95	1.74	5.3	16.40

Flooding and Erosion Threats

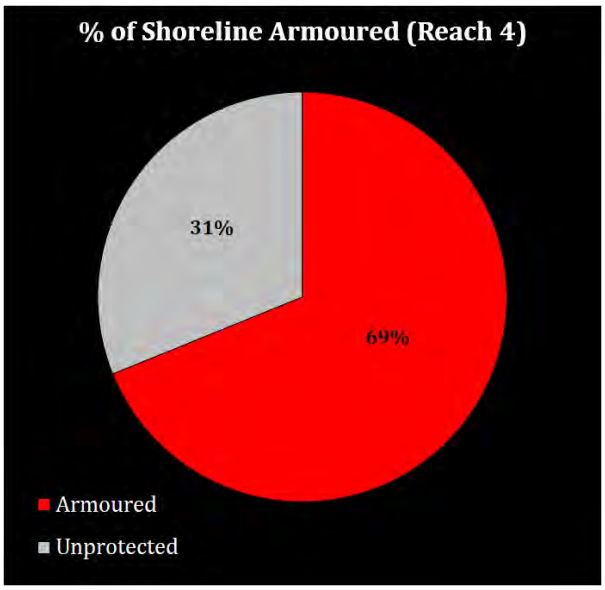
- The lakefront development is relatively free of flood risk for the 100-year lake level, with the exception of Lange Avenue and Surf Club Drive.
- The Fall 2019 oblique photography captured some areas of beach shoreline in Reach 4 that were sand bagged to protect from flooding.
- At the western end of the reach, the 100-year lake level will inundate the wetlands at Ruscom Shores Conservation Area and the agricultural land south of the CNR tracks. There is a sediment deficit for the beach shoreline at this Conservation Area due to shoreline armouring (see adjacent oblique photograph).

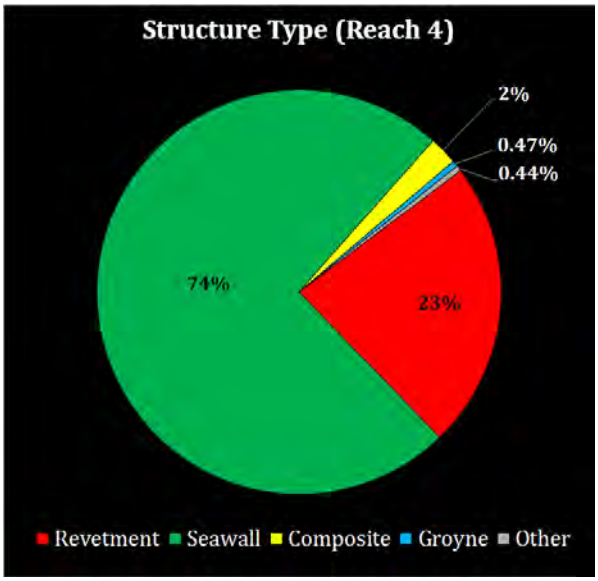
- This analysis does not consider riverine flooding from rainfall events, only coastal flooding.

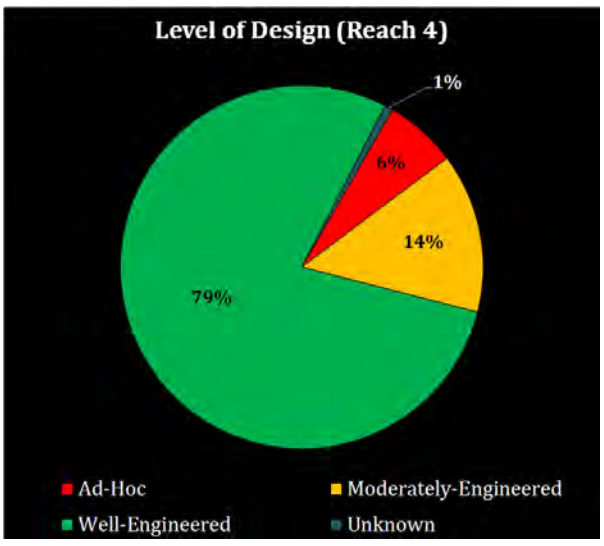
Existing Shoreline Protection Structures

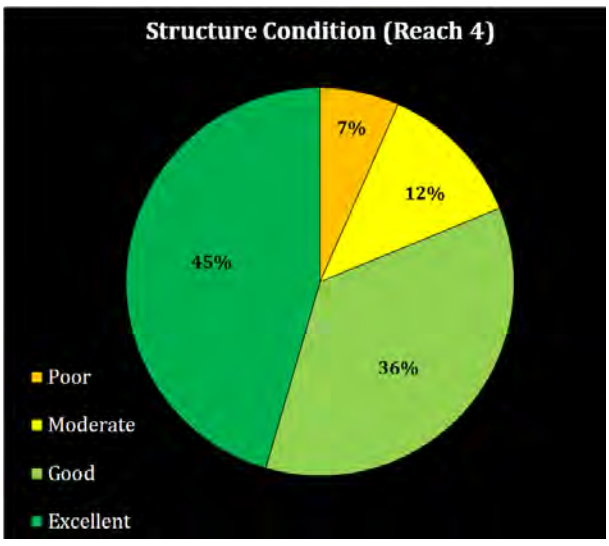
- The lake shoreline and riverbanks of Reach #4 are 69% armoured.

- The majority of the structures are vertical steel and concrete seawalls (74%), but armour stone revetments are also present (23%).
- A large percentage of the structures are well-engineered (79%), but many feature a low crest (top) elevation which contributes to coastal flooding.
- 81% of the shore protection is in good to excellent condition structurally but many should have been constructed with a higher crest elevation.









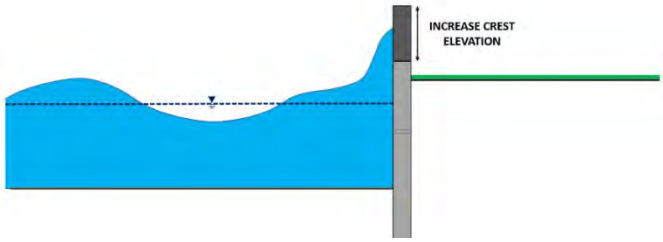
Recommendations for Shoreline Protection Structures

- Future studies should establish standard engineering design criteria for shoreline protection structures along the lake and riverbanks to reduce wave overtopping volumes and wave uprush, which contributes to lakeshore and interior flooding.

- Low lying beach shorelines will ultimately require some form of flood protection, such as a berm (refer to the Reach 3 recommendations) and sand nourishment to maintain the beach position. Refer to the eroded beach and exposed tree roots in the adjacent photograph.

- Eroding shorelines and ad hoc shore protection structures should be upgraded with an engineered solution. Examples include a headland beach system, a hybrid grey-green solution such as shore protection at the waters edge and a vegetated berm, or a traditional seawall or rock revetment.

- Raising the crest of existing shoreline protection structures is an effective mitigation strategy to wave overtopping and interior flooding. Refer to the adjacent schematic diagram.



- All sand bags and temporary geo-bags should be removed from the shoreline when a permanent engineered solution is installed. Refer to the temporary installment of geo-bags in the adjacent photograph.

Shoreline Management Recommendations

- Adopt standard engineering criteria for shoreline protection structures, including crest elevation, and flood mitigation requirements for lakefront and riverfront properties. Pursue a community scale solution for the flood prone portions of Reach 4 to increase resilience to coastal hazards with continuous shoreline protection and flood mitigation.
- Failed or low-crested shoreline protection should be upgraded based on new reach-scale standards.

- A long-term strategy is needed to protect the shoreline and wetlands of Ruscom Shores Conservation Area with a nature-based solution, such as a headland beach system. An offset between the armoured shoreline of Surf Club Drive and the eroding shores of the Conservation Area is seen in the oblique photograph below. Without action, this offset will get worse with time, leading to more habitat loss and erosion risk for the adjacent residential development.

Use Disclaimer

Reach 5 – Stoney Point East

Local Conditions

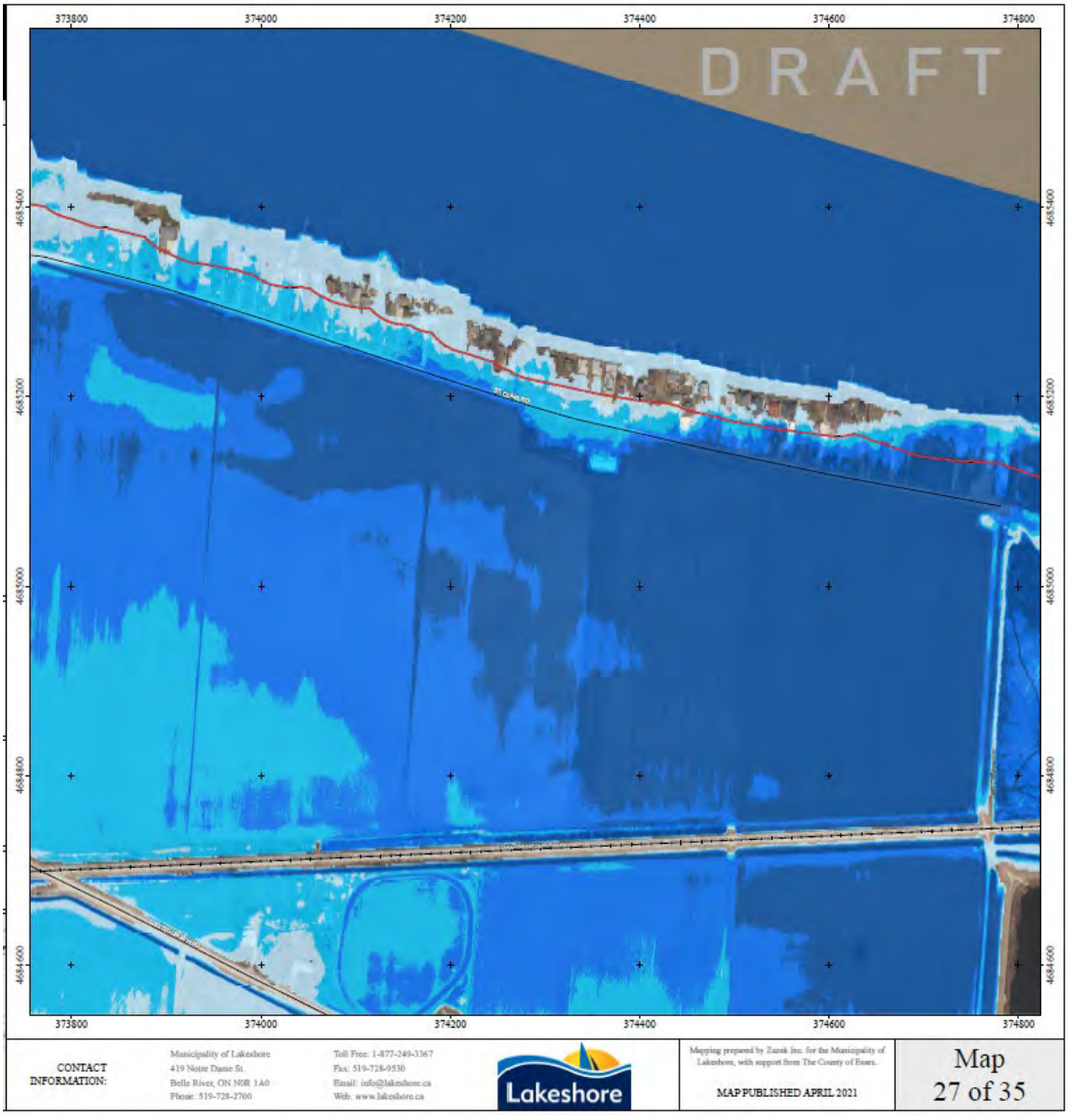
- Reach Length = approximately 3.9 km.
- The reach extends from the intersection of St. Clair Road and Columbus Drive in the geographic centre of Stoney Point to the east boundary of Tremblay Beach Conservation Area.
- Dense shoreline development and agricultural land south of St. Clair Road.
- Tremblay Beach Conservation Authority is one of the few natural areas along the shore and features extensive coastal wetlands.

Stoney Point Sportsman Club near West Boundary

Flooded Shoreline at Tremblay Beach Conservation Area

Depth of Road Flooding and Emergency Access

- At the western limits of Reach 5, there is no flooding on St. Clair Road for the 100-year lake level.
- East of Comber Side Road, lake flooding could propagate through the residential areas for the 100-year lake level, over the road and into the agricultural fields. Flood depths range of 0.31 to 0.9 m. This depth of flooding would limit emergency vehicle access in Reach 5.



Summary of Natural Hazards

- 100-year Erosion Rate (Stable Slope not included):

Start (UTM, Zone 17)	End (UTM, Zone 17)	100-year Erosion Rate (m/year)	Source
371883, 4686480	375726, 4685483	0.5	ERCA

- 100-year Lake Level:

Start (UTM, Zone 17)	End (UTM, Zone 17)	100-year Lake Level (m IGLD85')	100-year CC Lake Level (m IGLD85')
371883, 4686480	375726, 4685483	176.57	176.95

- Dynamic Beach(es):

Start (UTM, Zone 17)	End (UTM, Zone 17)	100-year Erosion Rate (m/year)	Dynamic Beach Name
n/a	n/a	n/a	n/a

- Nearshore Wave Climate for 100-year Wave Height:

Water Depth (m)	Significant Wave Height, H_b (m)	Maximum Wave Height, H_{max} (m)	Deepwater Wave Height, H_o (m)	Wave Period, T_p (seconds)	Wave Length, L (m)
2.0	1.23	1.59	1.74	5.3	22.72
1.8	1.11	1.45	1.74	5.3	21.65
1.6	1.00	1.32	1.74	5.3	20.50
1.4	0.90	1.19	1.74	5.3	19.26
1.2	0.79	1.08	1.74	5.3	17.90
1.0	0.69	0.95	1.74	5.3	16.40

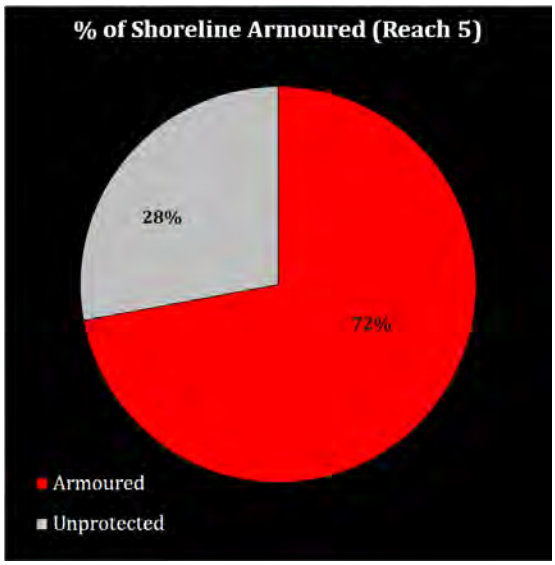
Flooding and Erosion Threats

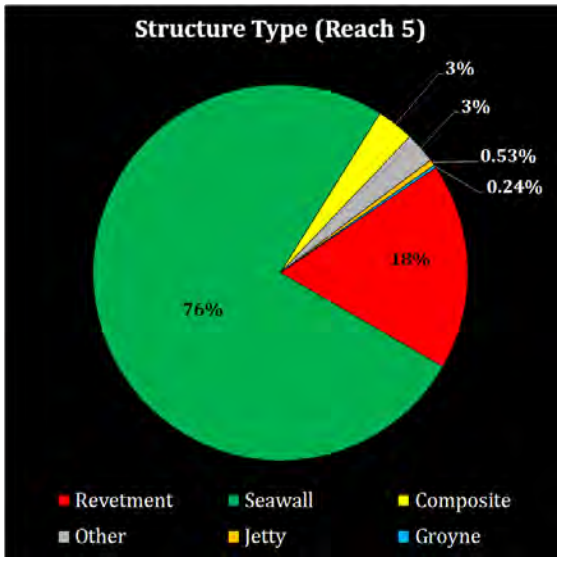
- Flooding along the lakeshore due to low-crested shore protection structures, unprotected beach properties, and low-lying land.
- Approximately half the lakefront properties are vulnerable to flooding for the 100-year lake level. New builds approved by the Conservation Authority are raised and the building foundations are above the 100-year lake level. However, many of the older developments are on low-lying land and vulnerable to flooding.
- Much of St. Clair Road is inundated by the 100-year lake level in Reach 5. Flood depths increase towards Tremblay Beach Conservation Area and are in the range of 0.61 to 0.9 m near the east reach boundary.
- Emergency ingress and egress would not be possible on St. Clair Road with vehicles along the central and eastern half in Reach 5.
- This analysis does not consider riverine flooding from rainfall events, only coastal flooding.

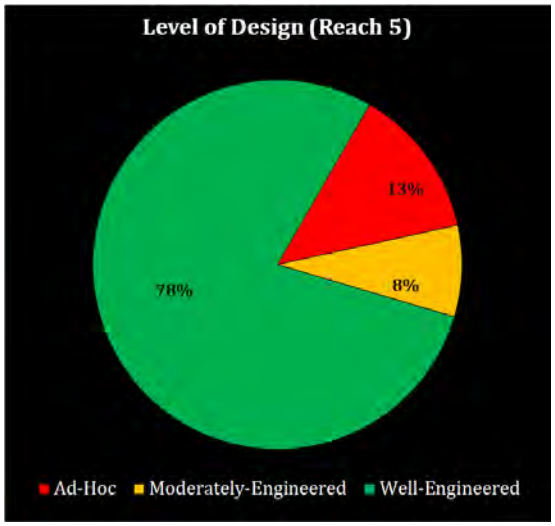
Existing Shoreline Protection Structures

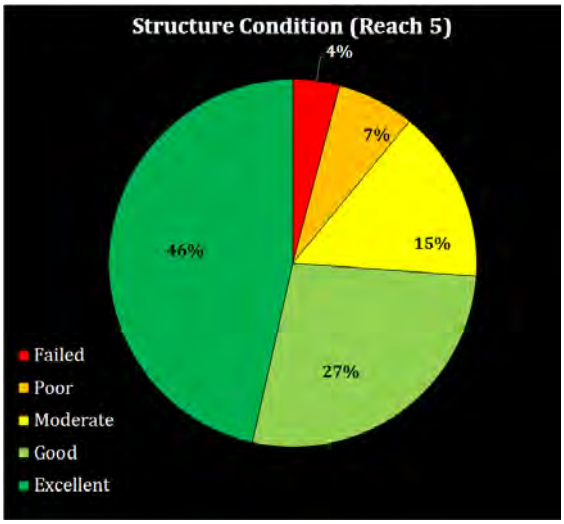
- The lake shoreline and riverbanks of Reach #5 are 72% armoured with shoreline protection.

- Majority of the structures are vertical steel and concrete seawalls (76%). Armour stone revetments are also present (18%).
- Most of the structures are well-engineered (78%) but many feature a low crest (top) elevation which contributes to coastal flooding.
- 73% of the structures are in good to excellent condition structurally but should have been constructed with a higher crest elevation.





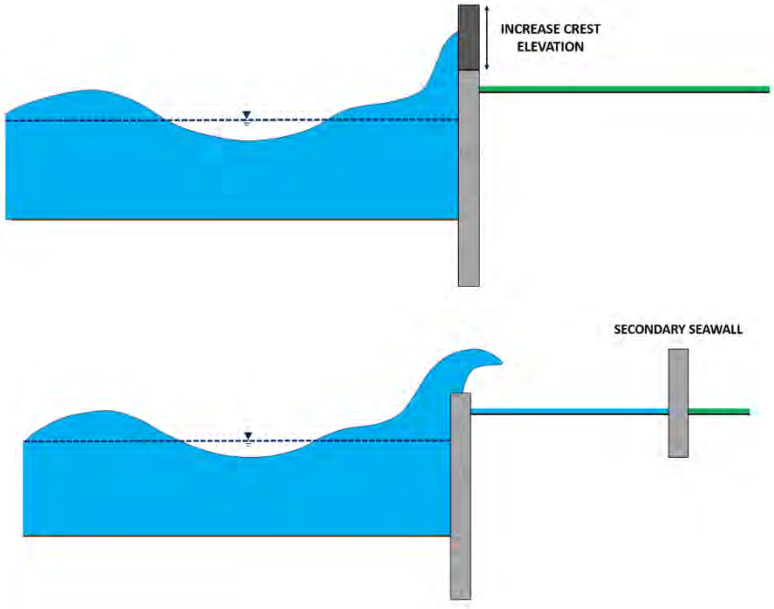




Recommendations for Shoreline Protection Structures

- Future studies should establish standard engineering design criteria for shoreline protection structures along the lake and riverbanks to reduce wave overtopping volumes and wave uprush, which contributes to lakeshore and interior flooding.

- Given the severity of the residential and road flooding, a continuous community scale shoreline protection upgrade plan should be pursued, with uniform design criteria such as a fixed crest height, and 100% participation by landowners. Raising the crest of existing shoreline protection structures, such as seawalls and revetments, is on viable option to reduce residential and agricultural flooding. Secondary walls further inland would also be effective.



- Unprotected properties represent flood pathways during the 100-year lake level and should be protected to reduce inland flooding threats. Berms or levees may be effective if located away from eroding shorelines.

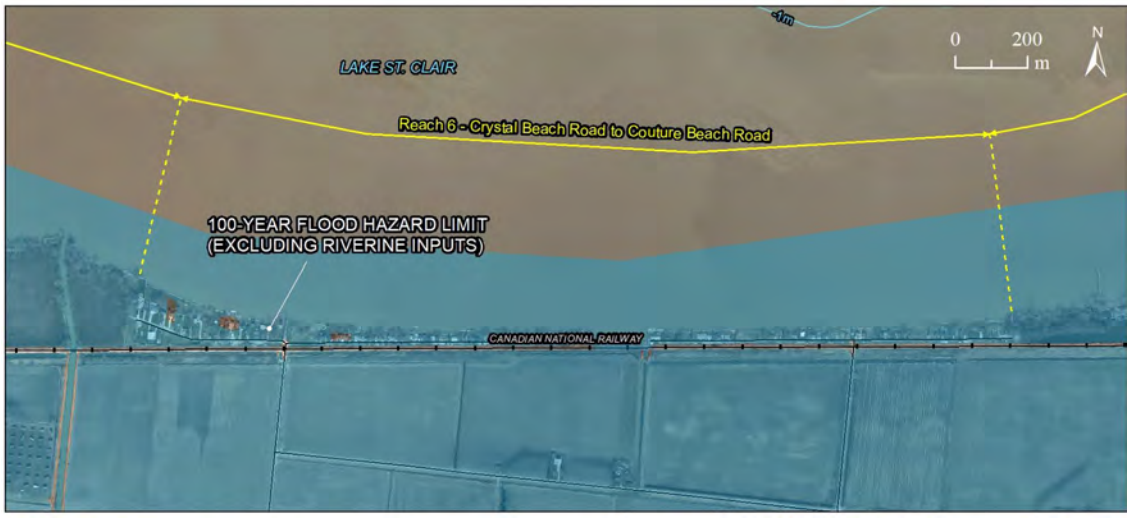
Shoreline Management Recommendations

- Adopt standard engineering criteria for shoreline protection structures, including crest elevation, and flood mitigation requirements for lakefront and riverfront properties. Pursue a community scale solution for the flood risk in Reach 5 to increase resilience to coastal hazards with continuous shoreline protection and flood mitigation.

- Individual buildings can be flood proofed by raising foundations, for example.
- Shorelines with natural beaches can be flood proofed with berms and levees to maintain access to the waters edge, provided it is part of continuous protection in the reach.
- Failed or low-crested shoreline protection should be upgraded based on new Reach 5 standards.
- Further assessment of emergency vehicle access during the 100-year flood is required, as the depth of flooding will limit access for the majority of St. Clair Road in Reach 5.

Use Disclaimer

Reach 6 – Crystal Beach Road to Couture Beach Road



Local Conditions

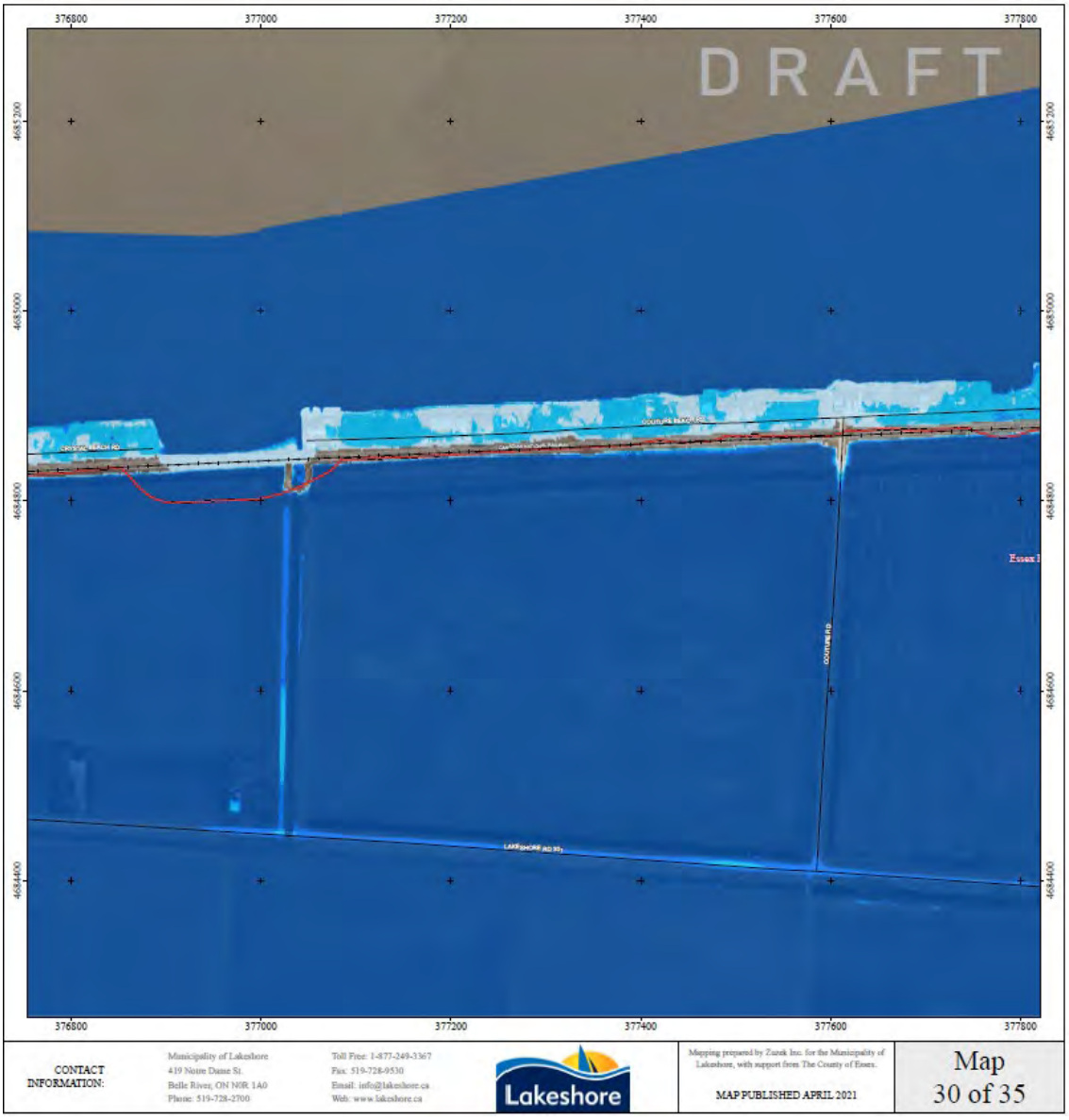
- Reach Length = approximately 2.4 km.
- Reach 6 includes Laforet Beach, Crystal Beach Road, and Couture Beach Road. The roads are low lying and access is threatened during flooding events.
- The development along Crystal Beach and Couture Beach Road features shallow lots bounded by the lake on the north side and the roads/railway embankment on the south. Locating and operating functional private septic systems will be a significant challenge on many lots.

Western Limit of Reach 6

Eastern Limit of Reach 6

Depth of Road Flooding and Emergency Access

- All three of the roads in Reach 6 are inundated by coastal flooding during the 100-year lake level. Significant portions of all three roads are flooded by 0.3 to 0.6 m of water.
- With ingress and egress to the lakeshore limited to Gracey Side Road, which is flooded by 0.61 to 0.9 m of water and Couture Road (>0.9 m of flooding) during the 100-year lake level, emergency access is a serious safety concern.



Summary of Natural Hazards

- 100-year Erosion Rate (Stable Slope not included):

Start (UTM, Zone 17)	End (UTM, Zone 17)	100-year Erosion Rate (m/year)	Source
375726, 4685483	377965, 4685471	0.5	ERCA

- 100-year Lake Level:

Start (UTM, Zone 17)	End (UTM, Zone 17)	100-year Lake Level (m IGLD85')	100-year CC Lake Level (m IGLD85')
375726, 4685483	377965, 4685471	176.57	176.95

- Dynamic Beach(es):

Start (UTM, Zone 17)	End (UTM, Zone 17)	100-year Erosion Rate (m/year)	Dynamic Beach Name
n/a	n/a	n/a	n/a

- Nearshore Wave Climate for 100-year Wave Height:

Water Depth (m)	Significant Wave Height, H_b (m)	Maximum Wave Height, H_{max} (m)	Deepwater Wave Height, H_o (m)	Wave Period, T_p (seconds)	Wave Length, L (m)
2.0	1.23	1.59	1.74	5.3	22.72
1.8	1.11	1.45	1.74	5.3	21.65
1.6	1.00	1.32	1.74	5.3	20.50
1.4	0.90	1.19	1.74	5.3	19.26
1.2	0.79	1.08	1.74	5.3	17.90
1.0	0.69	0.95	1.74	5.3	16.40

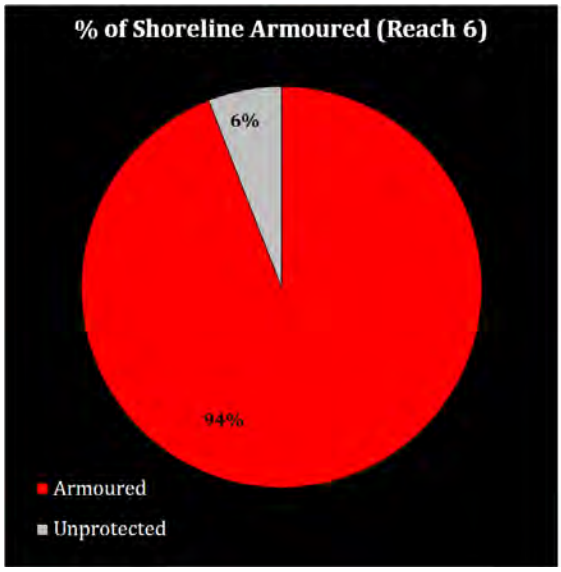
Flooding and Erosion Threats

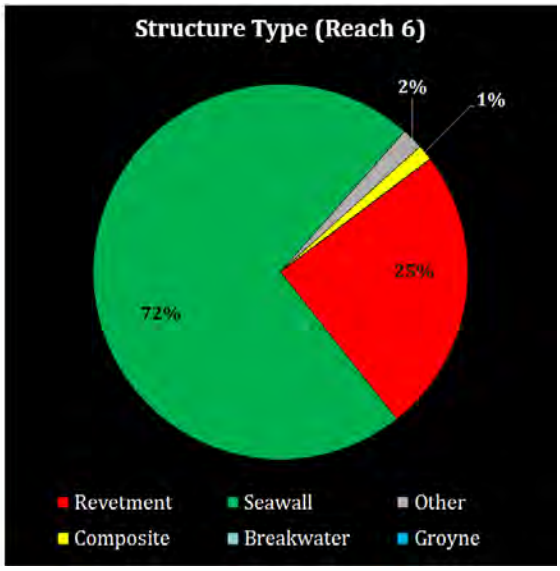
- With the exception of ~10 homes, every residential property would be flooded in Reach 6 during the 100-year lake level. This could be limited to wet exterior foundation walls or more severe basement and first floor flooding.
- Most private septic systems would be in failure during the 100-year coastal flood, as they'd be under water.
- Ingress and egress to Reach 6 is a serious concern, with the only two north-south access roads flooded by at least 0.6 m of water and greater than 0.9 m in some locations.
- The three lakeshore roads in Reach 3 are all under water during the 100-year lake level.
- Emergency evacuations or delivery of emergency services to Reach 6 would be almost impossible during the 100-year coastal flood with conventional vehicles.

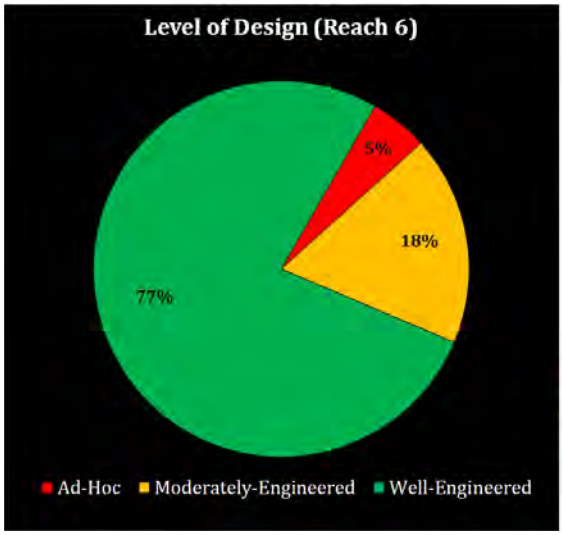
Existing Shoreline Protection Structures

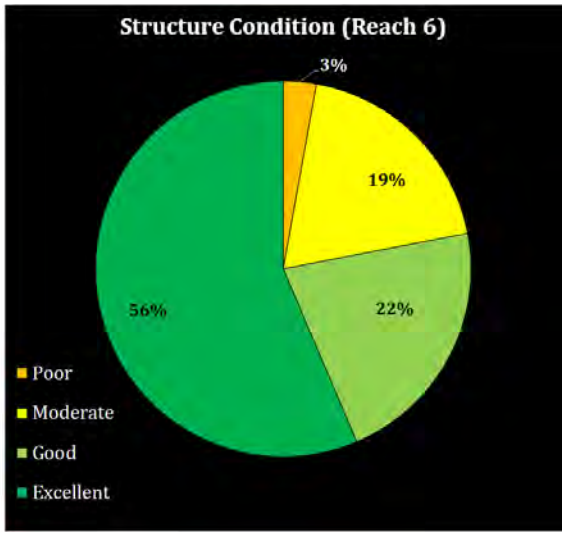
- The lake shoreline and riverbanks of Reach #6 are 94% armoured with shoreline protection.
- Majority of the structures are vertical steel and concrete seawalls (~72%). Armour stone revetments are also present (25%).

- Most of the structures are well-engineered (77%) but many feature a low crest (top) elevation which contributes to coastal flooding.
- 78% of the structures are in good to excellent condition (structurally).









Recommendations for Shoreline Protection Structures

- Future studies should establish standard engineering design criteria for shoreline protection structures along the lake to reduce wave overtopping volumes and wave uprush, which contributes to flooding along the lakeshore and interior flooding.
- Given the severity of the residential and road flooding in Reach 6, a continuous community scale shoreline protection plan should be pursued, with uniform design criteria and 100% participation by landowners. Raising the crest of existing shoreline protection structures and/or reducing overtopping with a rock

berm at the base of existing walls are potential options (refer to the examples below).

- Unprotected properties and ad-hoc structures should be upgraded as part of a community scale shoreline protection scheme for Reach 6 to reduce flood risk and support emergency vehicle access during the 100-year lake level.
- The shore protection between the terminus of Crystal Beach Road and Couture Beach Road should be monitored, as it is the last line of defence from erosion for the CNR tracks. Oblique photographs below.

Shoreline Management Recommendations

- Adopt standard engineering criteria for shoreline protection structures, including crest elevation and overall flood mitigation requirements for the lakefront properties. Pursue a community scale flood mitigation solution for Reach 6 to increase resilience to coastal hazards with a continuous flood mitigation strategy.
- Develop materials and recommendations for flood proofing of residential buildings.
- Emergency ingress and egress to Reach 6 and along the lakeshore should be restored with a large-scale mitigation strategy to protect people and property.

Safe ingress and egress are a requirement of the 2020 Provincial Policy Statement (Section 3.1.2 c) for all new development applications.

- Future development should not proceed on hazardous lands in Reach 6 unless the flood risk is mitigated and emergency vehicle access is attainable during the 100-year flood, as per Section 3.1.2 of the Provincial Policy Statement 2020.
- If community scale shoreline protection upgrades are not attainable and emergency vehicle access can not be restored to Reach 6, a property acquisition program from willing sellers should be developed. Appropriate controls (bylaws) on further development or redevelopment in Reach 6 would be implemented by the Municipality of Lakeshore.
- Private septic systems that are inundated during the 100-year lake level should be upgraded.

Use Disclaimer

Reach 7 – Lighthouse Cove

Local Conditions

- Reach Length (on Lake St. Clair) = approximately 2.7 km.
- The reach extends from Couture Beach Road in the west to the mouth of the Thames River.
- An extensive network of canals provides water access to most properties in Lighthouse Cove, but it also increases flood risk (canals convey flood water).
- The older development in Lighthouse Cove is vulnerable to coastal flooding and ice-jam flooding from the Thames River.

Western Limit of Lighthouse Cove

Eastern Limit of Lighthouse Cove

Summary of Natural Hazards

- 100-year Erosion Rate (Stable Slope not included):

Start (UTM, Zone 17)	End (UTM, Zone 17)	100-year Erosion Rate (m/year)	Source
377965, 4685471	379943, 4686602	0.3	ERCA

- 100-year Lake Level:

Start (UTM, Zone 17)	End (UTM, Zone 17)	100-year Lake Level (m IGLD85')	100-year CC Lake Level (m IGLD85')
377965, 4685471	379943, 4686602	+176.39	+176.77

- Dynamic Beach(es):

Start (UTM, Zone 17)	End (UTM, Zone 17)	100-year Erosion Rate (m/year)	Dynamic Beach Name
n/a	n/a	n/a	n/a

- Nearshore Wave Climate for 100-year Wave Height:

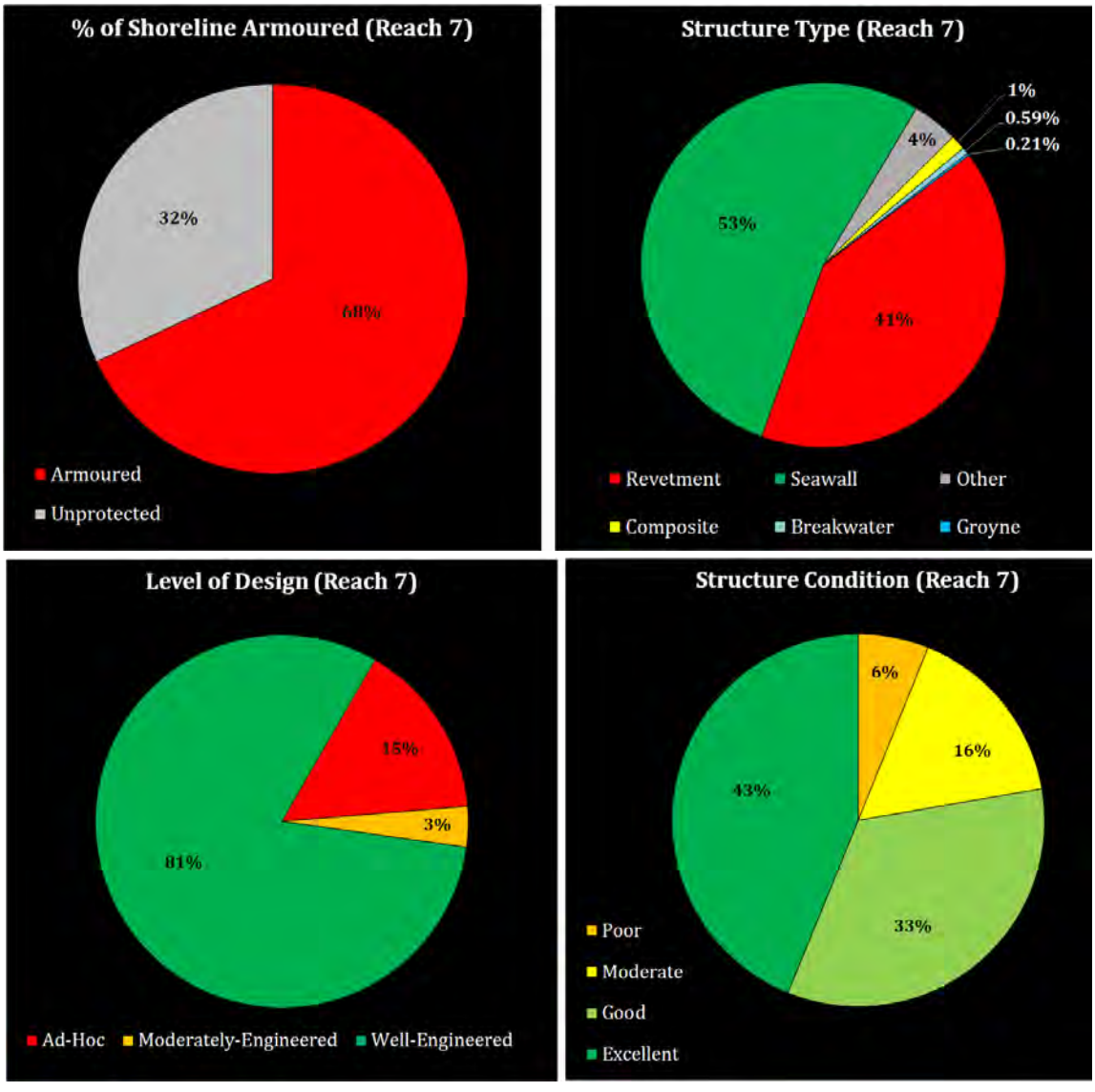
Water Depth (m)	Significant Wave Height, H_b (m)	Maximum Wave Height, H_{max} (m)	Deepwater Wave Height, H_o (m)	Wave Period, T_p (seconds)	Wave Length, L (m)
2.0	1.23	1.59	1.74	5.3	22.72
1.8	1.11	1.45	1.74	5.3	21.65
1.6	1.00	1.32	1.74	5.3	20.50
1.4	0.90	1.19	1.74	5.3	19.26
1.2	0.79	1.08	1.74	5.3	17.90
1.0	0.69	0.95	1.74	5.3	16.40

Flooding and Erosion Threats

- The older lakefront development is vulnerable to flooding during the 100-year lake level.
- The newer interior development of Lighthouse Cove is generally safe from flooding during the100-year flood due to enforcement of the Conservation Authority regulations for new development. Potential additional flood risks, associated with ice jamming of the Thames River, have not been analyzed for this study.
- Many of the roadways are flooded in Lighthouse Cove during the 100-year lake level, which will create challenges for emergency evacuation and delivery of emergency services.
- This analysis does not consider riverine flooding from rainfall events, only coastal flooding.

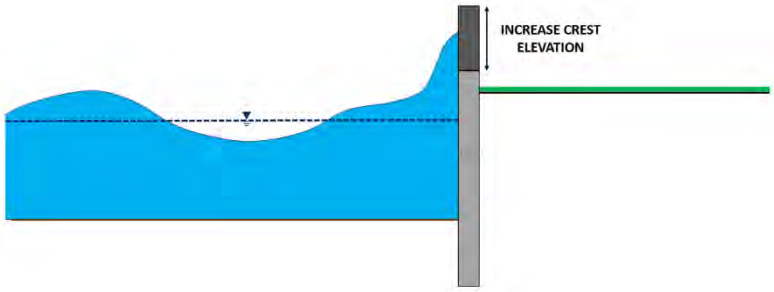
Existing Shoreline Protection Structures

- The lake shoreline and riverbanks of Reach #7 are 68% armoured with shoreline protection.
- Approximately half of the structures are vertical steel and concrete seawalls (53%). Armour stone revetments are also present (41%).
- Most of the structures are well-engineered (81%) but many feature a low crest (top) elevation which contributes to coastal flooding.
- 76% of the structures are in good to excellent condition, structurally, but low crested.

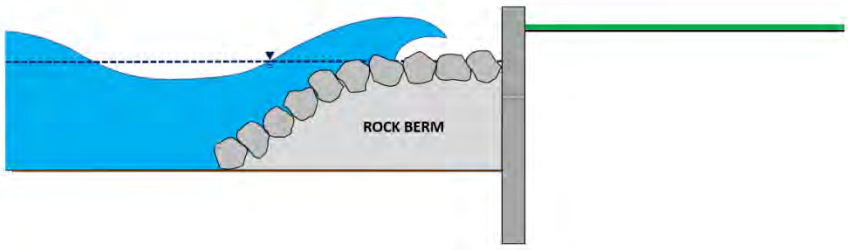


Recommendations for Shoreline Protection Structures

- Future studies should establish standard engineering design criteria for shoreline protection structures along the lake and riverbanks to reduce flood risk.
- Raising the crest of existing shoreline protection structures is an effective mitigation strategy to wave overtopping and interior flooding. Refer to the schematic diagram below.



- Another common mitigation approach is the construction of a rock berm at the base of existing vertical walls to dissipate incoming wave energy before it impacts the existing seawalls. Refer to the schematic diagram below.



- Unprotected properties should be upgraded with engineered berms, natural vegetation buffers, and/or engineered shore protection to mitigate wave runup and interior flooding.

Shoreline Management Recommendations

- Adopt standard engineering criteria for shoreline protection structures and flood mitigation. Increasing flood resilience will require continuous mitigation.

- Further assessment of emergency vehicle access during the 100-year flood and the 100-year climate change flood is required, as the depth of flooding is significant is some areas of Reach 7.
- Future residential development in Reach 7 should not continue until safe ingress and egress is possible for first responders on the local road network. If safe access is secured, further development must be appropriately flood proofed as per guidance from the Conservation Authority.

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