

TECHNICAL MEMORANDUM

Date:	March 12, 2026	File No.	2025.023.001
To:	Rene Doucette	From:	Watershed Engineering Ltd.
Client:	Rene Doucette – Property Owner		
Project Name:	4535 Mill Road		
Reference:	Flood Hazard Assessment for Floodplain Exemption		

1. BACKGROUND

Watershed Engineering Ltd. was retained by Rene Doucette to prepare a Flood Hazard Assessment to support a floodplain exemption application for the property located at 4535 Mill Road in Naramata, British Columbia, hereafter referred to as “the site”. The site is defined with the following legal address:

- Lot 21, Plan KAP3889, District Lot 211, Similkameen Division of Yale Land District (SDYD), with Parcel Identifier (PID): 010-694-463

The site is bounded by the Okanagan Lake shoreline to the south and by Mill Road to north. Refer to Figure 1.0 for a delineation of the project site area complete with the civic address and legal parcel description. The property owner is proposing the development of a single-family dwelling on the site, which is located within the floodplain extent of Okanagan Lake as defined under the Regional District of Okanagan-Similkameen (RDOS) *Schedule G – Hazard Lands – Floodplain* of the *Electoral Area “E” - Naramata Official Community Plan (OCP) Bylaw No. 3010*. The purpose of completing a Flood Hazard Assessment for this project was to analyse the site-specific flood hazards and provide recommendations for mitigation options to ensure safe development of the proposed single-family dwelling and support the floodplain exemption application. The scope of Watershed Engineering’s work is as follows:

- Complete a background review of the site, proposed development plan, and all supporting information including studies and all applicable standards, guidelines, and bylaws relevant to the site flood hazard assessment.
- Conduct a site investigation to identify and assess design considerations and potential mitigation options
- Conduct a bathymetric survey to determine the topography of Okanagan Lake leading up to the shoreline of the site
- Prepare a site-specific wind-wave analysis based on the projected design instantaneous peak lake level for Okanagan Lake. The projected Okanagan Lake design level was determined by Northwest Hydraulic Consultants Ltd. (NHC) for the Okanagan Basin and Water Board (OBWB) in their 2020 *Okanagan Mainstem Floodplain Mapping* report, which was referenced to determine the flood hazards mapping for *Schedule G* of the *OCP Bylaw No. 3010*.

- Develop design mitigation options for the proposed development based on results of the wind-wave analysis.
- Prepare a technical memorandum outlining the methodology, results, and recommendations of the flood hazard assessment to supplement and support the floodplain exemption for construction within the designated floodplain setback line.

Information about the proposed development plan relevant to the flood hazard assessment is as follows:

- Development Footprint: 115.75 m²
- Development Setback Distance from Lakeshore (shortest distance): 6.14 m
- Main Floor Elevation: 345.0 m

Refer to Figure 1.1 and Figure 1.2 for the proposed development plan of the site outlining the setbacks and the proposed main floor elevation, respectively. The Okanagan Lake natural boundary is defined along the edge of the rock wall / edge of the manicured grass area along the southern property boundary (Cassidy, 2025). The Okanagan Lake natural boundary was established prior to the subdivision of land which created the properties 4535 and 4545 Mill Road, therefore the lake natural boundary location applies to both properties. The RDOS *Okanagan Valley Zoning Bylaw No. 2800* outlines that no building or structure shall be located within 7.5 metres of the natural boundary of any lake. The proposed development is setback 6.14 m from the Okanagan Lake natural boundary and is therefore within the designated floodplain setback distance; requiring a floodplain exemption application accompanied by the following flood hazard assessment analysis and mitigation recommendations to ensure safe development of the site.

1.1 Technical Standards and Guidelines

The RDOS *Okanagan Valley Zoning Bylaw No. 2800* provides floodplain regulations for development in Naramata, and the RDOS *OCP Bylaw No. 3010* provides guidance on flood hazard management for development in Naramata. NHC's 2020 *Okanagan Mainstem Floodplain Mapping* report provides a comprehensive analysis and summary for the projected Okanagan Lake design lake level which forms the basis of the Schedule G – Hazard Lands – Floodplain mapping for Naramata. The following includes all technical standards and resources used to develop the methodology and recommendations in this memorandum:

- RDOS Okanagan Valley Zoning Bylaw No. 2800 (2022, last amended March 2026)
- RDOS Electoral Area “E” - Naramata OCP Bylaw No. 3010 (2023, last amended October 2025)
- Schedule G – Hazard Lands – Floodplain – Electoral Area “E” OCP Bylaw No. 3010 (October 2023)
- RDOS Website – Development Services – Planning – Application Forms & Resources – Floodplain Exemptions (accessed March 2026)
- OBWB Okanagan Mainstem Floodplain Mapping (March 2020)
- 4545 Mill Road Riparian Area Protection Regulation (RAPR) Assessment Report (March 2025)
- Ministry of Forests, Lands, Natural Resource Operations and Rural Development (MFLNRO) – Flood Hazard Land Use Management Guidelines (May 2004, last amended January 2018)
- MFLNRO – Coastal Floodplain Mapping Guidelines and Specifications (June 2011)
- Engineers and Geoscientists of British Columbia (EGBC) – Guidelines for Legislated Flood Assessments in a Changing Climate in BC (Version 2.1, August 2018)
- US Army Corps of Engineers Coastal Engineering Manual Part – IV (2011)

1.2 Site Inspection

A site inspection was completed by Caleb W. Pomeroy, P.Eng. and Christopher Foerderer, E.I.T. on March 11, 2026. The purpose of the inspection was to review the existing site conditions, review the shoreline bathymetry, and note any concerns relevant to the proposed development layout relative to the flood hazard from Okanagan Lake. Refer to Appendix A for the site inspection photographs. Notable observations from the inspection are as follows:

- The rock wall along the southern property boundary appears to be poor condition and should not be relied upon for long-term erosion protection of the property (Photos 3 & 4).
- Erosion of the shoreline without mitigation could cause slope regression into the property, reducing the offset to the natural boundary.
- There is a shallow bench along the littoral zone extending into the bay from the Natural Boundary of the subject property.
- Evidence of erosion and past mitigation was noted on the shoreline extending east and west from the subject property.
- Existing grade on the property appears low and would be partially inundated during the design event.

2. RELEVANT DOCUMENT REVIEW SUMMARY

The following includes key background information, findings, and recommendations:

- Okanagan Valley Zoning Bylaw No. 2800:
 - **Section 10.1.1:** The following land is designated as a floodplain:
 - c) any land that is less than 1.5 metres above the natural boundary of any other watercourse.
 - **Section 10.1.2:** The flood construction level for land designated as a floodplain in section 10.1.1 is:
 - d) Okanagan Lake: 343.66 m Geodetic Survey of Canada (GSC) datum.
 - **Section 10.2.3:** Despite any other provisions of this Bylaw, no building or structure shall be located within 7.5 metres of the natural boundary of any lake, pond or marsh, or the top of bank where the bank is within 7.5 metres of the natural boundary of any lake, pond or marsh.
 - **Section 10.4.1:** No person shall place any structural support for a habitable area or fill required to support a habitable area on land within a floodplain setback area under Section 10.2.
 - **Section 10.4.2:** No person shall construct, reconstruct, move or extend a floor system or pad which supports a habitable area, such that the underside of the wooden floor system or the top of the pad or the ground surface on which it is located, is lower than the flood construction levels specified in Section 10.1.
 - **Section 10.4.6:** The following developments and uses are excluded from the requirements of the floodplain management regulations specified in Sections 10.4.2 and 10.4.3:
 - b) that portion of a building or structure to be used as a carport or garage.
- RDOS Website – Development Services – Planning – Application Forms & Resources – Floodplain Exemptions:
 - If your property is within the designated floodplain an exemption may be required if you intend to build with a floor elevation lower than the Flood Construction Level, or within the Floodplain

Setback Line. Applications for a Floodplain Exemption require the submission of an application fee, completed application form and supporting documentation (i.e. site plans) as well as the submission of a professional report prepared by a suitably qualified individual (i.e. registered engineer or geoscientist). If an exemption is granted, a covenant stating the conditions for exemption is placed on the title of the affected property.

- RDOS OCP Bylaw No. 3010:
 - **Section 18.5: Flood Hazard Management:** The flood hazards now included at Schedule 'G' (Hazard Lands – Floodplain) are based on the mapping prepared by the OBWB in 2020 and the 1994 Naramata fan study.
 - **Section 18.5.1: The Regional Board:**
 3. Requires that where land subject to flooding is to be developed and no alternative land is available, construction and siting of buildings and manufactured homes to be used for habitation, business, industry, or the storage of goods damageable by floodwaters shall comply with the floodplain regulation of the Zoning Bylaw with any relaxation subject to the recommendations of a report prepared by a qualified Professional Engineer or Geoscientist, where applicable.
 4. Supports minimizing exposure to future flood damage by avoiding development adjacent to Okanagan Lake or by implementing flood mitigation measures.
 5. Supports mitigating the impacts of potential flooding on buildings and properties in the floodplain area and affected by groundwater through design and site grading prior to construction as per the recommendations of a report prepared by a qualified Professional Engineer or Geoscientist.
- EGBC Legislated Flood Assessments in a Changing Climate in BC:
 - **Appendix F: F2.2.2:** Where a proposed building site is located in an area adjacent to a creek, river, lake, or ocean that is not protected by a Dike, the need for both Dike works and Mitigation Measures must be considered. In general, new buildings should be considered for unprotected floodplains only if:
 - i) The local government has adopted an appropriate bylaw or land use regulation that provides for building Construction with knowledge of the Flood Hazard, or the Qualified Professional concludes that the site may be suitable for intended use.
 - ii) The FCL should be at the 200-year return period flood level plus Freeboard (0.3 m for instantaneous peak floods and 0.6 m for daily peak floods).
 - iii) Particular attention needs to be given to specification of appropriate on-site Mitigation Measures such as foundation design, method of achieving FCL, and site grading.

3. FLOOD CONSTRUCTION LEVEL

In accordance with the recommendations in the 2020 *Okanagan Mainstem Floodplain Mapping Project*, site-specific wave runup analysis by a Qualified Professional may be warranted to refine the generalized wave effects determined for Okanagan Lake, which could increase or decrease the FCL by as much as a metre (Northwest Hydraulic Consultants Ltd., 2020). Additionally, the MFLNRO *Coastal Floodplain Mapping – Guidelines and Specifications* (2011) outlines that a Building Code or Standard does not exist in Canada for coastal processes and procedures; therefore, estimation of expected wave effect(s) should be

determined using recognized engineering reference documents for guidance, along with engineering judgement for best management practice.

To determine the wave effect on the design flood event, the approach followed in this assessment was to use the Canadian Dam Association (CDA) *Dam Safety Guidelines 2007 (2013 Edition)* and C.D. Smith’s *Hydraulic Structures (1995)* for wind setup and wave runup determination. The Flood Construction Level was determined by applying the determined wave effect to the NHC (2020) projected design instantaneous peak Okanagan Lake level, which was selected as the design event, and applying the recommended Freeboard.

3.1 Design Event Peak Lake Level

NHC (2020) reports the recommended projected design event (adjusted for future climate change) as the 2017 event in mid-century with an elevation of 343.86 m in the CGVD2013 datum. The site development is referenced to the CGVD28 HTv2.0_2002 datum and NHC (2020) recommends using Natural Resources Canada’s (NRCan’s) online tool GPS-H to convert between the CGVD2013 and CGVD28 HTv2.0_2002 datum. Table 3-1 provides the site-specific information input into NRCan’s GPS-H tool to project the CGVD2013 datum lake elevation to the CGVD28 HTv2.0_2002 datum.

Table 3-1: CGVD 2013 to CGVD28 HTv2.0_2002 Datum Lake Elevation Conversion

Zone	Easting (m)	Northing (m)	CGVD2013 Elevation (m)	CGVD28 HTv2.0_2002 Elevation (m)
UTM11	312235.000	5498236.000	343.86	343.69

As outlined in Table 3-1, the peak lake level determined for the site during the design flood event is 343.69 m. The determined design flood event is reported by NHC (2020) as having an average recurrence interval that is slightly greater than the 500-year event.

3.2 Wind and Wave Analysis

A wind and wave analysis was performed to determine the site-specific wind and wave effects at the property. Wind data was obtained from NHC (2020) based on a wind analysis performed on Penticton wind station data. Table 3-2 shows the northerly and southerly wind speeds determined for the Penticton Station.

Table 3-2: Northerly and Southerly Design Wind Speeds

Average Return Interval	Wind Speed at Penticton Station			
	Northerly		Southerly	
(years)	(m/s)	(km/hr)	(m/s)	(km/hr)
1	12.3	44.3	16.6	59.8
2	13.8	49.7	17.7	63.7
5	15.4	55.4	18.9	68.0
10	16.5	59.4	19.8	71.3
20	17.6	63.4	20.6	74.2
50	19	68.4	21.6	77.8
100	20.0	72.0	22.4	80.6
200	21.1	76.0	23.2	83.5

The CDA *Dam Safety Guidelines 2007 (2013 Edition)* define a significant consequence classification dam as having an Inflow Design Flood with a recurrence interval between 100 and 1000 years and suggest that a 10-year wind velocity be utilized for minimum freeboard calculations at this classification. Given that the selected design flood event has an average recurrence interval slightly greater than the 500-year event, the 10-year Penticton wind velocity was selected for analysis based on the assumption that the design event's return period is somewhere between 500 and 1000 years. The wind speed selected for analysis was the 10-year southerly wind of 19.8 m/s.

The 10-year wind speed was used to calculate the wind setup, significant wave height, and wavelength resulting from wind blowing over the water. The equations used for calculations are as follows (Smith, 1995):

For Wind Setup:

$$S = \frac{FV^2}{63000D}$$

Where:

- S = Wind tide or Setup (m)
- F = Fetch length (km)
- V = Wind velocity over water corrected for fetch length (km/hr)
- D = Average reservoir depth over fetch length (m)

For Significant Wave Height:

$$H_w = 0.00513V^{1.06}F_e^{0.47}$$

$$F_e = KL$$

Where:

- H_w = Significant wave height (m)
- V = Design wind velocity (km/h)
- F_e = Effective fetch length (km)
- L = Maximum straight unobstructed water length facing the dam (km)
- K = Fetch correction factor based on the relation between the average reservoir width (in km) and L

Based on the CDA (2013) recommendations for freeboard calculations, an additional factor of 1.37 is applied to the calculated significant wave height to determine the design wave height, which is the average of the highest 5% of waves.

For Wavelength:

$$L_o = 0.187V^{0.88}F_e^{0.56}$$

Where:

- L_o = Wavelength (m)
- V = Design wind velocity (km/hr)
- F_e = Effective fetch length (km)

A bathymetric survey was conducted to determine the slope of Okanagan Lake leading up to the site shoreline. Wavelength is used in conjunction with the embankment slope (Okanagan Lake slope leading up to shoreline) to determine the relative runup ratio of the wave (Smith, 1995). The relative runup ratio is then multiplied to the design wave height to determine the wave runup on the shoreline. Table 3-3 summarizes the results for the wind and wave analysis.

Table 3-3: Wind and Wave Analysis Results

Design Wind Frequency	10-year
Wind Setup (m)	0.021
Significant Wave Height (m)	0.89
Wave Runup (m)	0.38
Wind Setup + Wave Runup (m)	0.40

3.3 Site-Specific Flood Construction Level

The site-specific FCL was computed as the design peak lake level plus wind setup, wave runup, and an additional 0.6 m of freeboard, as determined by NHC (2020). Table 3-4 summarizes the design peak lake level, wind setup, wave runup and freeboard, along with the determined FCL for the site.

Table 3-4: Input Parameters and Site-Specific Flood Construction Level

Design Peak Lake Level (m)	343.69
Wind Setup + Wave Runup (Wave Action) (m)	0.40
Design Peak Lake Level + Wave Action (m)	344.09
Freeboard (m)	0.6
Flood Construction Level (m)	344.69

4. DISCUSSION

The proposed building main floor elevation is set at an elevation of 345.0 m, which is above the determined site flood construction level of 344.69 m. The proposed development plan demonstrates that the foundation of the building is likely to be subject to wave action during the design event peak lake level. The 2014 American Society of Civil Engineers (ASCE) *Flood Resistant Design and Construction* standard defines flood hazard areas along lakes as “A Zones” where wave heights are less than 3 feet (0.9 m). Based on this definition, the site can be classified under “Zone A” as it is on the shoreline of a lake and the wave height is less than 0.9 m.

Structural fill should be used only in flood hazard areas not susceptible to high velocity wave action and structural fill used for foundation support and protection should be properly designed, constructed and protected (American Society of Civil Engineers, 2014). The U.S. Army Corps of Engineers’ *Coastal Engineering Manual* provides guidelines on calculating localized scour depth on structures resulting from wave exposure. The following relationship for scour depth around structures was used to estimate the localized scour depth at the site’s foundation (USACE, 2011):

$$S_m = H_m$$

Where:

- S_m = Maximum scour depth at a vertical wall (Maximum scour occurs when the vertical wall is located around the plunge point of the breaking wave)
- H_m = Nonbreaking significant wave height wave height (0.89m)

Based on the above relationship the total estimated scour depth due to wave action is 0.89 m.

Based on observations noted during the site inspection, the rock wall located along the southern property boundary is not likely to provide long-term erosion and encroachment protection from Okanagan Lake. The analysis and recommendations provided in this report are based on existing site conditions. Potential future encroachment of the Okanagan Lake natural boundary into the site caused by erosion of the rock wall will alter site conditions, and therefore must be actively monitored and addressed if apparent.

5. RECOMMENDATIONS

The technical analysis completed in this study has determined the flood construction level and shoreline impacts due to wave action and demonstrates that although a flood hazard is present, the property can be safely developed for its intended use provided the following recommendations are implemented. A flood assurance statement is provided in Appendix B.

1. The flood construction level which includes the mid-century adjusted 2017 flood of record, wind setup, wave runup, and 0.6 m freeboard is 344.69 m for the subject property.
2. The foundation is to be designed by a structural and geotechnical engineer based on the flood construction level of 344.69 m and estimated scour depth of 0.89 m due to wave action outlined in this report.
3. The geotechnical design for bearing capacity of the foundation is to consider saturated conditions.
4. The structural design of the foundation is to consider wave forces, pressures and runup.
5. The site survey data was collected using the CGVD28 vertical datum and horizontal control is NAD83(CSRS) UTM Zone 11N. For establishing of benchmarks and elevation control for the FCL, the referenced vertical datum must be used.
6. The existing rock wall condition is maintained or improved if future degradation or erosion occurs.

The proposed single-family dwelling floodplain setback can be reduced from 7.5 m to 6.14 m provided that the above recommendations are implemented into the final building design.

6. CLOSURE

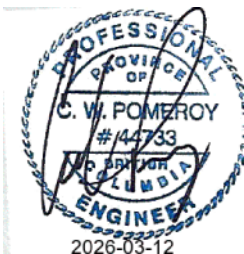
We trust this memo meets your requirements. Should you have any questions, please contact the undersigned.

Sincerely,

Watershed Engineering Ltd.

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LIST OF FIGURES

Figure 1.0 – Site Plan with Civic and Legal Addresses

Figure 1.1 – Proposed Development Plan Outlining Setbacks

Figure 1.2 – Proposed Development Plan Outlining Building Main Floor Elevation

LIST OF APPENDICES

Appendix A – Site Inspection Photographs

Appendix B – Flood Assurance Statement

