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nhc
northwest hydraulic consultants ltd

NHC Ref. No. 3001570

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Horizon Engineering Inc.
220 – 18 Gostick Place
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V7M 3G3

Attention: **Karim Karimzadegan, P.Eng**

Via email: Karim@HorizonEng.ca

Re: **Gibsons Flood Construction Level Assessment**
Final Report

1 INTRODUCTION

Northwest Hydraulic Consultants (NHC) was retained by Horizon Engineering Inc. (Horizon) to assess the coastal flood hazard and resulting Flood Construction Level (FCL) previously determined by Horizon and adjust if necessary for the proposed mixed use development (The George). The development is located in the town of Gibsons, BC on properties 377, 385 & 407 Gower Point Road, 397 & 689 Winn Road, and Winn Road Right of Way (Figure 1).

2 FCL ASSESSMENT

The additive approach presented by the provincial Ministry of environment (MOE) was used for developing the site specific flood construction level (FCL). These guidelines (Climate Change Adaption Guidelines for Sea Dikes and Coastal Flood Hazard Land Use (Ausenco-Sandwell, 2011) suggest an approach for developing a FCL calculated as the summation of potential coastal flood events; that is:

FCL = Higher High Water Level Large Tide (HHWLT)
+ design storm surge
+ design sea level rise (SLR)
+ local subsidence
+ wave effects from design storm
+ freeboard

Referred to as Designated Flood Level (DFL)

Referred to as the Flood Construction Reference Plane (FCRP)

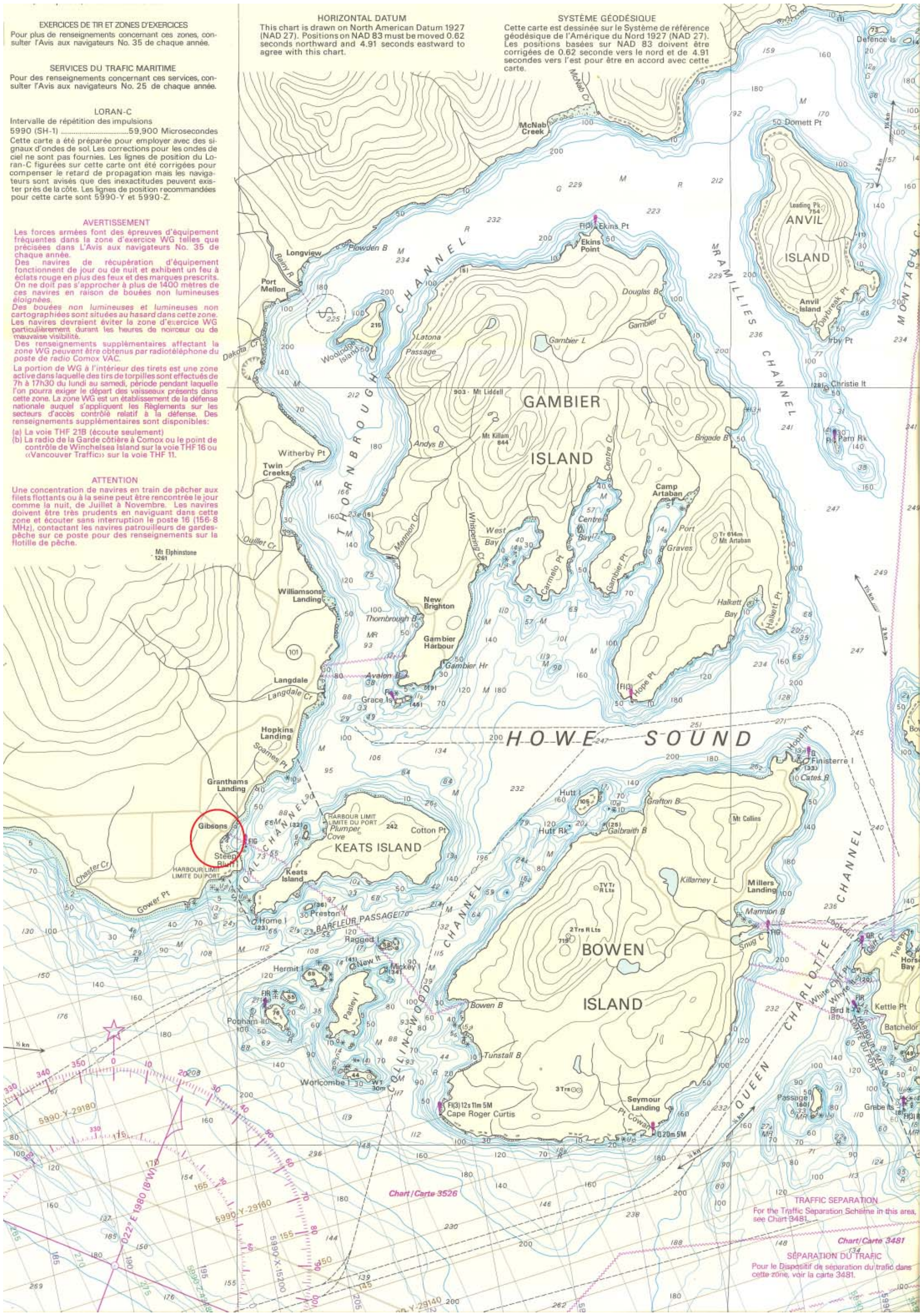

Figure 1. **Project Location (Canadian Hydrographic Services, 3512)**
Chart is for location purposes only – do not rely on for navigation.

2.1 Wind/Wave Analysis

The 200-yr design wind event has been calculated from Pam Rocks wind station (10459NN) to be 23 m/s from the northeast. Using a fetch length of 12 km the 200-yr design wave event has been calculated as 1.3 m significant wave height with a period of 4.1 seconds.

2.2 Wave Effects from Design Storm (Wave Diffraction and Run-up)

The study property is located along the shore of Gibsons Marina which is protected by two riprap breakwater structures. Wave height distribution in a protected marina is determined by the diffraction characteristics of both the natural and manmade structures providing protection from the design wave. When the wave enters the opening between the breakwaters it diffracts around the structure resulting in a reduction of wave height. The diffraction coefficient for the property location is estimated to be 0.4 to 0.8 for the site (USACE, 1984) which results in the design wave height being reduced to 0.52 to 0.91 m. Additional refinement of the design wave can be done through numerical modelling of wave generation and transformation.

The restaurant is pier supported and located away from the shore slope – it will therefore experience a wave effects equivalent to half of the reduced design wave height, 0.26 m. For the path on the seawall (i.e. sea walk) and infrastructure above the sea wall it has been assumed that a 2H:1V rock riprap slope is armouring the bank; the resulting wave run-up (2% of waves exceedance level) is calculated as 0.94 m.

2.3 Tide Levels and Vertical Datum

Baseline tidal water levels obtained from Canadian Hydrographic Services (CHS) 7820 Station for Gibsons are presented in the table below.

Table 1. Water Levels at Gibson Marina

Tides	Water Level (m, CD)[1]
Higher High Water, Large Tide (HHWLT)	5.22
Higher High Water, Mean Tide (HHWMT)	4.52
Mean Water Level (MWL)	3.17
Lower Low Water, Mean Tide (LLWMT)	1.20
Lower Low Water, Large Tide (LLWLT)	0.03

[1] Conversion from Geodetic (GD) to chart datum (CD) is 3.19 m.

2.4 Storm Surge

Storm surge is caused by weather effects (wind setup, wave setup, atmospheric pressure uplift) on the ocean. The 200-year storm surge value was calculated from Point Atkinson water level data by removing the tidal component from the measured water level and conducting Extreme Value Analysis using the “Peak Over Threshold” method . The 200-year storm surge has been calculated as 1.15 m.

2.5 Sea Level Rise (SLR)

Sea level rise to be experienced at the site is the sum of the global rise in sea level during the design life plus the local ground subsidence during the same period; negative if local ground is experiencing uplift. The Provincial Climate Change Adaptation Guideline (Ausenco-Sandwell, 2011) suggests using a global SLR value of 10 mm/yr for BC dike design from the year 2000. Uplift and subsidence has been ignored for this analysis due to the lack of site specific information. It is assumed this is conservative as uplift is noted in much of the region and there has been no indication (from the Horizon) that the site is on fill or other locally subsiding material. The resulting SLR is 0.65 m for year 2065.

2.6 Freeboard

Freeboard for infrastructure should be 0.6 m.

It is assumed that the sea walk is providing access and is not to be used as a dike. The consequence of the sea walk being inundated is also assumed to be substantially less than other infrastructure and a lower freeboard and/or possibly a reduced design event; 20-year or 50-year storm may be more appropriate for its design. For this study, the 200-yr event has been used with a 0.2 m freeboard.

2.7 FLC Summation

Based off the above assessment the FCL is calculated to be:

Table 2. Summary of FCL Inputs (m)

FCL Input	Pier Supported Restaurant (m)	Shoreline Infrastructure (m)	Sea Walk (m)
HHWLT (El. CD)	5.22	5.22	5.22
+ Design Storm Surge	1.15	1.15	1.15
+ Design SLR for 2065	0.65	0.65	0.65
+ Wave/Run-up	0.54	0.94	0.94
+ Freeboard	0.60	0.60	0.20
FCL in CD	**8.16**	**8.56**	**8.16**
FCL in GD	**4.97**	**5.37**	**4.97**

The calculated FCL of El.5.37 m (GD) should be used for the sea dike crest or for habitable, commercial, or other flood susceptible infrastructures.

The calculated FCL of El.4.97 m (GD) should be used for the proposed pile supported restaurant.

The calculated FCL of El. 4.97 m (GD) may be used for shoreline sea walk assuming that the walkway is not also being used for coastal flooding protection (i.e. as a sea dike).

The flood construction levels have been calculated using empirical method of deriving the design wave and the additive approach for assessing hazard. The FCL can be further refined through numerical modelling of wave and water level conditions.

Design of the sea dike to withstand fluctuation of tide, scour, erosion, and drainage is not included in this work, but should be considered. Tsunami hazard has not been investigated as part of this assessment, however based on work from other sites in the region it is not expected to be the governing hazard.

3 CLOSURE

If you have any questions, please do not hesitate to contact Dale Muir or Graeme Vass by email (dmuir@nhcweb.com | gvass@nhcweb.com) or by phone 604.980.6011.

Sincerely,

Northwest Hydraulic Consultants Ltd.

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4 REFERENCES

Ausenco-Sandwell. 2011. Climate Change Adaptation Guidelines for Sea Dikes and Coastal Flood Hazard Land Use; Guidelines for Management of Coastal Flood Hazard Land Use. Report prepared by Ausenco-Sandwell for BC Ministry of Environment.

Coastal Engineering Manual. (CEM). 2002. US Army Corps of Engineers.

US Army Corps of Engineers (USACE). 1984. Shore Protection Manual Volume I.

DISCLAIMER

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