COMMENTS ON "EXTREME OCEAN CONDITIONS AT THE BUCKLEY BAY – DENMAN ISLAND FERRY CROSSING" BY CASCADIA COAST RESEARCH LTD.

Report prepared by

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Summary

This document provides comments on meteorological conditions outlined in "Extreme Ocean Conditions at The Buckley Bay – Denman Island Ferry Crossing" (the Report) prepared by Cascadia Coast Research Ltd for BC Ferries. The Report highlights that it is critical that those using its results understand its limitations. The findings in this document focus on two of the main limitations: A) Gusts (or any wind averages shorter than 6 minutes) were not of interest despite the American Petroleum Institute's (API) requirement to use one minute averages or gusts for moorings designs. B) Mid channel winds were not measured,despite currents and waves having been measured, even though they are expected to be considerably higher from winds at the ferry terminals, especially during strong wind events,.

Sustained Wind Speeds and Gusts at the Terminals

Adjusting 6 minute averages to API standards of 1 minute averages.

BC Ferries committed to using standards established by the American Petroleum Institute (BC Ferries, 2012) and its standards require that one of two methods be used to assess effects of wind for design. These methods include either the use of 1-minute average wind speeds (with no consideration for gust speeds) or 1-hourly averaged wind observations and the use of an appropriate gust spectrum. The Report states that gust speeds are "not of interest" (Cascadia 2012, Appendix A6), which leads to the conclusion that the first method is intended to be used. Since the Report used 6-minute wind speed averages, B.C. Ferries may want to consider the associated change in measured wind speeds as it is not clear from the Report if this will be done. The expected increase in extreme wind speed measurements associated with a decreased averaging time from 6 minutes to 1 minute is expected to be within 14% to 18%. (Vickery 2005, Krayer and Marshall 1992 and Durst 1960). This correlation is based on the

assumption (Krayer and Marshall, 1992) that the terminal anemometer is mounted at 10 meters height and located in "open terrain" (i.e. an area where the distance between the anemometer and any obstruction is at least 10 times the height of the obstruction, as per WMO 2008). It should also be noted that the aviation observations from Comox measure sustained winds at 2 minute averaging intervals and should also be corrected to 1 minute intervals if they are to be used to inform any part of the ferry or mooring design.

For completeness it must be stated that the recorded maximum gust at Comox airport was 159 km/h in October 1990, which is 71% higher than the maximum recorded sustained wind speed of 93 km/h from November 1962.

Lack of Mid-Hourly Observations and Effects of Down-Sampling

Observations which measure only at the top of each hour can miss short-lived wind events occurring between observations. Since only hourly observations were considered at the ferry terminals and in Comox, a more detailed look into the effect on the wind spectra at the terminals is warranted, since it may result in an upward correction of wind speeds during extreme events. A cursory examination of remarks from Chrome Island and special reports from Comox during five extreme wind events (March/12/2012, December/11/2006, December/31/2008, January/4/2009, November /12/2007) revealed that the intensity of these large scale wind events were captured reasonably by hourly observations. There are two exceptions, however, on November 12th 2007 and December 31, 2008, when gust observations at Chrome Island were recorded up to 100 knots between main observations. Main observations reported gusts not exceeding 60 knots.

Manual Observations

It is not clear how, when and where the manual onboard observations were measured, recorded and subsequently stored/reported. The Report states that manual observations are consistently higher than automated observations due to human error or bias , which does not reflect my considerable experience in using manual and automated observations. In particular, the degree of their disagreement (up to 50%, during the more important high wind speeds) warrants, a closer examination of the reason for the discrepancy. It is worth noting that the Chrome Island Lighthouse observations were also recorded manually, but included in the report without considering human bias or error.

Direction specific gust susceptibility of the Denman West Terminal

Cold frontal passages across the south coast of B.C. are commonly accompanied by a wind shift from southeast towards south/southwesterly directions and associated gusts. The south and westerly component during such events exposes the Denman West Terminal to gusty winds. The examination of the same five extreme wind events mentioned above in Lack of Mid-Hourly Observations and Effects of Down-Sampling, discovered wind gusts reaching southerly (180 degrees) at 83 knots on December 12, 2006 associated with the aforementioned frontal wind shift. While the intensity of this frontal shift at the Denman West Terminal is unknown, it should be noted that such intense gusts may occur more

frequently than every 100 or 50 years. If southwesterly gust exposure of the terminal is important to the mooring design, a more detailed review is warranted.

Anemometer Height

It was difficult to ascertain from the report (in scanned PDF format) how the terminal anemometers were mounted. Since the placement of anemometers needs to be close to the terminals in order to measure representative winds, the exact location may not have allowed for the sites to abide by API standards. It is worth noting, however, that API requires that anemometers be mounted exactly 10 meters above still water level to advise mooring designs (API 2005). Corrections can be applied to account for decreased wind measurements if anemometers are mounted lower.

Mid Channel Wind Speed

Little is known about sustained wind and gust speeds at mid channel between the Denman West and Buckley terminal since no observations were collected. The Report suggests that a factor of 1.2 (referenced to the USACE Coastal Engineering Manual) can be applied to the terminal observations, but it also states that "**no** simple method can **accurately** represent the complex relationship between on-shore and off-shore wind speeds" (emphasis added). On the topic of simplified estimation of overwater wind speeds from land measurements, the USACE Coastal Engineering Manual states: "If at all possible, it is advisable to use locally collected data ... for a particular project". Additionally, the Report has found a much higher factor of 2.12 (the reciprocal of 0.47) between the nearest off shore station (Chrome Island) and the on-shore terminals. In light of the complex terrain surrounding the site, the potential funnelling of southeasterly winds between Denman and Vancouver Island, the highly pronounced southeasterly wind exposure (fetch) at mid channel and, finally, the fact that wave and current information was already measured mid channel, it is advisable that in-situ mid channel wind observations be used for design purposes. Generic approximations derived from the on shore terminal observations are not appropriate. In my experience with onshore/offshore and (partially) channelled winds, a generic correction factor of 1.2 may underestimate some extreme mid channel wind speeds significantly.

Reviewed Material

"Extreme Ocean Conditions at the Buckley Bay – Denman Island Ferry Crossing"; Cascadia Coast Research Ltd; Final Report; Revision 1, August 31, 2012, pg 1-10

"Extreme Ocean Conditions at the Buckley Bay – Denman Island Ferry Crossing"; Cascadia Coast Research Ltd; Results Summary; Revision 1.1,October 11, 2012, pg 1

"Extreme Ocean Conditions at the Buckley Bay – Denman Island Ferry Crossing"; Cascadia Coast Research Ltd; Appendices, Revision 1, August 31, 2012, pg A1-A14

"Baynes Sound Environmental Characterization Study", IV – Instrumentation Specifications and Installation, Rev. 1, August 13, 2012, pg 1

References and Resources

American Petroleum Institute (API), October 2005, "Design and Analysis of Stationkeeping Systems for Floating Structures", Upstream Segment, Recommended Practice 2SK, 3rd edition

B.C. Ferries, November 2012, "Public Information Session Cable Ferry Project Denman Island"

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USACE, August 2008, "Coastal Engineering Manual"

Vickery, P.J., Skerlj, P.F., May 2005, "Hurricane Gust Factors Revisited", *Journal of Structural Engineering* DOI: 10.1061/(ASCE)0733-9445(2005)131:5(825)

World Meteorological Organization (WMO), 2008, "Guide to Meteorological Instruments and Methods of Observation", WMO-No.8, seventh edition.

Yours sincerely,

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