Tracey Saxby
Executive Director,
My Sea To Sky

July 18, 2025

In response to your request to review the validity of the conclusions of the 2025 WLNG summary memo titled, "*Henriette Lake Dam Wave Modelling Summary*" this document provides my comments as an independent consultant with dam breach experience. There is also background provided on the limitations of river modelling software used for other purposes such as estimation of ocean impact wave heights.

The memo and the Northwest Hydraulics Consultants (NHC) report appear to underestimate the potential for ocean wave generation by a dam breach flood. There are likely several reasons for this that could be confirmed if the report was made available.

My work as a P. Geo. (Geophysics) staff consultant with a major engineering company includes managing and technical oversight of dam breach studies using HEC-RAS 2D river flood modelling and the modelling of impact wave propagation for water bodies using analytical and empirical methods.

Due to the limited information available at this time (lack of access to the referenced Oct 27, 2022 NHC source report *"Henriette Lake Dam Breach and Consequence Classification Analysis"* that the memo is based on, comments on conclusions of the memo are not full professional opinions about the NHC report. The comments that follow are simply observations about the summary memo which extracts from the report.

The memo "2025 WLNG memo – Henriette Lake Dam Wave Modelling Summary.pdf" appears to have been written by WLNG staff not involved in the analyses done in the NHC report and does not provide any basis for it's conclusions.

Despite it's name, the memo is possibly not actually a summary of a *wave modelling study*, more accurately it is likely a summary of a *dam breach river flood level study* with un-supported commentary on the heights of ocean resulting from the impact of a dam breach flood on the ocean surface.

Without review of the methodology of the NHC report, it is not clear if the modelling done in the 2022 NHC report (which appears to be HEC-RAS2 river modelling), included any dynamic ocean wave modelling in either Woodfibre Creek, or of the ocean in the area of the floatel mooring location to support comments made regarding ocean wave heights from a dam breach.

However, HEC-RAS2 models are not full dynamic ***wave*** models (as needed in the open ocean), HEC-RAS2 is primarily software for river flow modelling used to predict rise and fall of water ***levels*** in river channel ***flows.*** HEC-RAS2 does have some transient modelling capabilities, but it is not clear if these were used in the study.

The NHC dam breach report appears to present a valid model of dam break flows in Woodfibre Creek, but somehow there is an unsupported and possibly invalid comment quoted in the memo that "suggests" that the large (10 m to 15 m high as modelled by NHC) dam breach impact wave in

Woodfibre creek would “rapidly attenuate” in the short distance from the last modelling point on the shoreline to the floatel mooring location.

Floatel #2 will be close to shore as it will be connected to the shoreline by a pedestrian ramp which would likely be less than 25 m long. This ramp may be located in or near the impact zone and could be highly susceptible to wave damage or debris flow damage.

Modelling of waves in the open ocean is not what HEC-RAS2 is designed for. It is thus not surprising that it’s output figure (NHC Figure 22) would show rapid loss of wave height due to loss of confinement upon exiting the creek mouth. However, the slug of water from the dam breach wave that NHC modelled as being 10 m to 15 m high and moving at 6 m/s or more, will certainly not attenuate in short distances and would simply continue into the ocean under it’s own momentum. Once this slug of water traverses the beach section (in a few seconds at 6 m/s) and crosses into deep enough water, the large ocean waves expected to be generated by the momentum of the slug would <u>not dissipate rapidly</u> (on the ocean free surface waves can travel many miles).

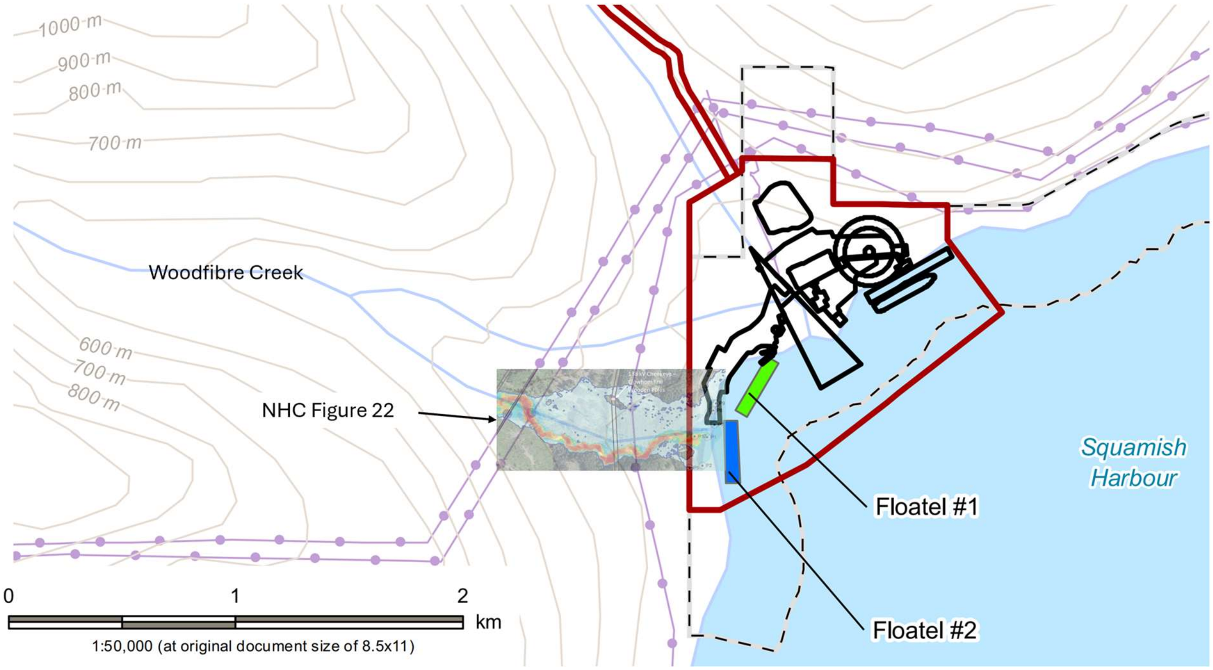
When considering the validity of the conclusions in the memo, please note an important distinction in terminology is required: “*Dam Breach Modelling*” is often referred to as “*Dam Breach Wave Modelling*” even though it is typically simplified river channel level modelling using the shallow water wave equation which is distinct from “*Dynamic Wave Propagation Modelling*” using the full wave equation.

Full Wave Equation propagation modelling of dynamic effects is necessary for making accurate predictions of wave attenuation in rapidly varying water depths or on the ocean surface. In the case of Dam Breach models, the term “flood wave” is used to refer to the rise and fall of the overall arriving water level front in the channel, whereas “wave propagation” models incorporate dynamic wave equation modelling of the propagating oscillations of each individual free surface wave.

Figure 22 of the NHC 2022 report shows river modelling flow heights diminishing as they are extrapolated out into the area of the Woodfibre foreshore immediately adjacent to where the present floatel is now moored. It is not clear if water levels derived from a river flood model are appropriate to show in the ocean where wave propagation dominates, not water level effects. As the low flood <u>water level</u> heights seen in the NHC river model figure at the ocean water’s edge show, you cannot “flood” the ocean, but you can certainly create large, damaging waves there that propagate long distances on the ocean surface.

The memo neglects to indicate the location of either the present floatel or the proposed location of floatel #2 which also makes it difficult to assess the validity of the comments about wave attenuation as distance is a key factor in attenuation. Figure A) based on a Stantec figure, shows that floatel#2 would be immediately adjacent to the mouth of Woodfibre Creek. Based on the scale of the figure, floatel#2 would be at approximately 20 m to 40 m from shore.

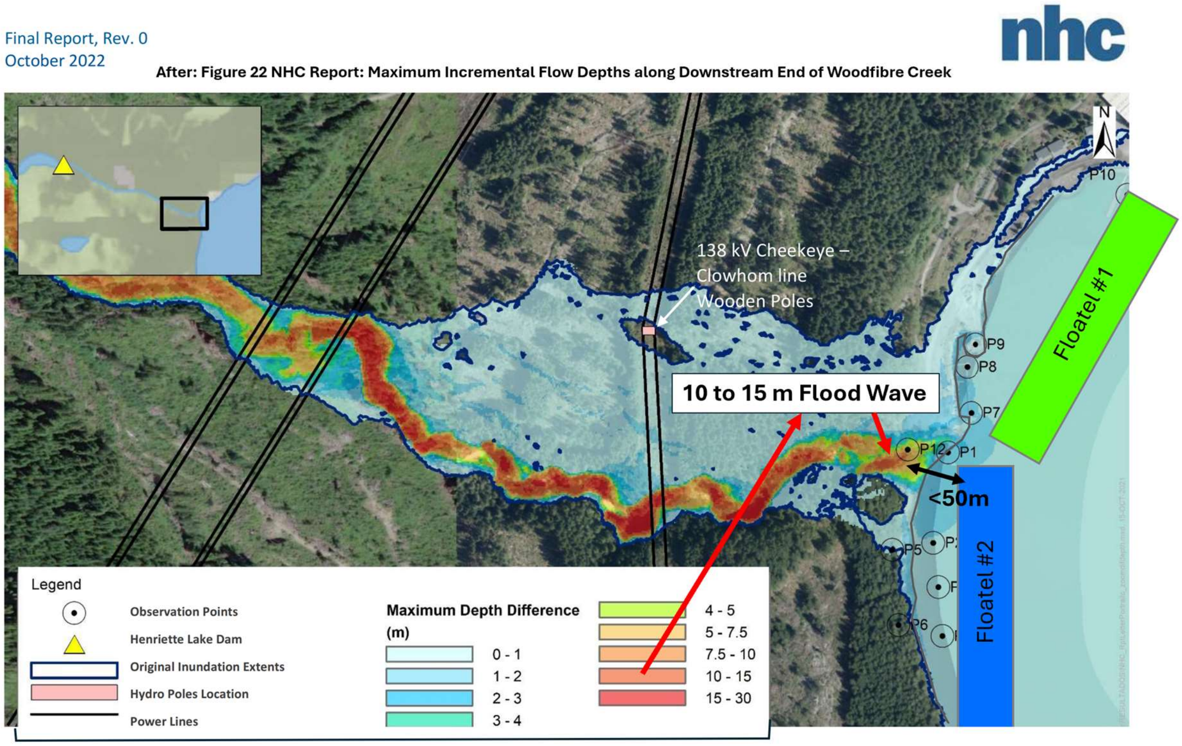
Figure A) NHC Figure 22 of Flood Wave overlain on Stantec Figure of Floatel Locations



The main concern about the memo is whether the summary comment that states "waves will be rapidly attenuated" is based on valid wave propagation modelling, or is the comment simply based on a simple visual assessment of Figure 22 made by NHC that may not be valid at all in the area of the ocean.

As a simplification and rule of thumb, it is often assumed that persistent ocean waves cannot be sustained that are higher than the water depth. However, the momentum of large wavefronts such as a 15 m high slug of rapidly moving dam breach water can traverse a region of shallow water with little attenuation and generate a large ocean wave once deeper water is reached. Figure B shows the proximity of floatel #2 to the NHC region modelled with 10 m to 15 m high flood waves from a dam breach.

Figure B) Approximate floatel locations added to NHC Figure 22 (based on locations in Stantec Figure)



The NHC study appears to be valid for dam breach water heights ("Flood Wave") within the creek itself (but leaves out effects of debris flow factors which can compound flow heights, impact wave generation and consequences of a dam breach).

It is not clear if the NHC modelling was appropriate for assessing impact generated waves on the ocean surface.

A famous person once said that "All models are wrong, some are useful". This should be extended to say that "some models aren't even applicable".

HEC-RAS2 models are not typically used for extrapolating heights of dynamic impact waves entering water bodies. There are many model and analytical methods that are used for this, I have supervised the use of some of these methods by hydraulic engineers in forecasting impact wave heights caused by landslides and avalanches into lakes and tailings ponds.

Accurately modelling impact wave effects on free surfaces such as lakes or the ocean typically requires techniques like Finite Element Modelling (FEM) as embedded in computation fluid dynamic modelling software (such as FLOW-3D Hydro, Tsunami3D, or OpenFOAM). However, there are simplified analytical models based on empirical experiments that have been confirmed to work reasonably well to estimate impact wave heights and their attenuation with distance based on the velocity and mass impacting a water surface.

In conclusion, the memo simply makes unsupported assertations that "suggest" there will be no significant waves, but no specific supporting evidence whatsoever is provided in the memo as a basis for this assertation.

The memo also references and summarizes a snippet from another source "*Henriette Dam Breach Assessment Memorandum – 2025*" and again makes similar "suggestions" about wave height drawn from another unsupported assertation.

Both summaries seem to be overly dismissive of potential ocean wave amplitudes given the large amount of energy that will be deposited during a dam breach/debris flow event.

It is worth noting that a debris flow event can significantly amplify impact wave effects (by holding back water that piles up behind the plug of moving debris and subsequently increasing flow velocities and momenta upon release). Creek debris flows can also occur in the absence of a dam breach, simply from heavy rainfall. Steep creeks like Woodfibre Creek that have been starved of floods for decades because of the presence of a dam are even more susceptible to increased debris flow risk due to the absence of floods to scour accumulated sediment and debris in their channels.

In order to perform an actual professional review and to render an opinion on the conclusions of the memo (and the validity of conclusions extracted from NHC report as summarized in the memo) on wave height and attenuation at the floatel locations, it will be necessary to obtain the actual full text of the NHC study (or studies if there has actually been any new work). The exact floatel locations and foreshore bathymetry will also be needed to examine the appropriateness of the methodology used for predicting ocean wave heights.

Regards,

Graham Parkinson, P. Geo.