Stantec

Memo

To:	Leroy van Wieren Cowichan Valley Regional District	From:	Matt Wood, P.Eng. Stantec Consulting Ltd.
File:	Cowichan Lake Weir – Whitewater Recreation Opportunities	Date:	November 25, 2021

Reference: Cowichan Lake Weir – Whitewater Recreation Opportunities and Related Hydrotechnical Information Transmittal

1.0 BACKGROUND

From June 12 to July 12, 2020, as part of the effort to create a new weir design that would be able to store adequate water for future needs, while reflecting the visual, environmental and recreational goals of the community, an online survey was posted to solicit input from the community and stakeholders about what they thought should be considered in the new design. The following question was included in the survey, *"There is potential for the outflow to serve as both a fishway and a watercourse. Would you like to see recreational opportunities included in the design if possible? If so, let us know your thoughts in the comment box."* Feedback from the survey included many requests to consider incorporation of some form of whitewater features into the design of the weir upgrades[1]. The online survey had a considerable amount of respondents (46%) who indicated that they do not live or own a recreational property in the Cowichan Valley Regional District. Online posts in public forums suggest that local and regional whitewater associations encouraged their members to provide feedback on the survey for the project.

On December 10, 2020, Stantec held an online open house event for the preliminary design of the Cowichan Lake Weir upgrades and released information to the public about the proposed works as they had been designed at that time in the project.

It is our understanding that one of the whitewater associations has secured funding to conduct a feasibility study on opportunities to incorporate whitewater features into the Cowichan Lake Weir. In response to this, the Cowichan Valley Regional District (CVRD) has requested technical information on the hydraulics at the site to provide to this stakeholder and their consultant team.

This memorandum summarizes Stantec's communications with this stakeholder and their consultant team and compiles technical information relevant to the objectives of their study. The memo also provides Stantec's opinion on the technical feasibility of incorporating whitewater features into the design of the weir upgrades. This memo does not address funding opportunities for such features under the current project grant, nor does it address environmental and regulatory considerations, nor ownership and associated liabilities of having a whitewater facility on the Cowichan Lake Weir. Those items should be studied under a separate scope prior to determining the feasibility of such an addition to the structure.

[1] Grouped as *all respondents*, 78% of survey respondents would really like/like to see recreation opportunities included in the design if possible. When broken down into two groups, recreation opportunities were less supported by *residents or property owners* at 59% and more strongly supported by *non-residents/non-property owners* at 99%.

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2.0 BASIS

Our compilation of technical information and our opinion on feasibility is based on:

- The Cowichan Valley Weir Design Consultation Summary Report (which includes the Cowichan Valley Weir Design Survey Results).
- Meeting notes supplied by the stakeholders containing the findings of the site visit with their consultant and some of their considerations for whitewater features dated June 28, 2021. Those meeting notes are appended to this memo as Attachment #1.
- The PowerPoint slideshow presentation provided to the stakeholders and their consultants at the August 18, 2021, meeting. This presentation is appended to this memo as Attachment #2.
- The project's Preliminary Design Report titled: Cowichan Lake Weir: Preliminary Design Report

3.0 STAKEHOLDER MEETING

An online meeting was held on August 18, 2021, to discuss the project, the available information and the potential opportunities for whitewater recreation at the facility. Present at the meeting were Leroy Van Wieren (CVRD), Edmond Duggan and Rick Bryan, both who are members of a local paddling group, Vancouver Island Whitewater Paddling Society (VIWPS), Darren Shepherd from SG1 Water Consulting Ltd. (SG1), Gary Lacy from Recreation Engineering & Planning (REP) and Matt Wood (Stantec).

At the meeting, Stantec presented a series of slides (Attachment #2) which focus on several key pieces of information that we felt would inform SG1 and REP's assessment. The slides included information on the:

- Proposed plan (layout of proposed weir design and related elements such as fish passages)
- Proposed weir geometry
- South abutment sill area
- Hydrotechnical information from the Preliminary Design:
  - Operational rule curve
  - Weir rating curves
  - Hydraulic model overview
  - Historical monthly discharge from proposed weir

Included with this memo is a series of preliminary design drawings that show the geometry and general arrangement of the proposed weir and its appurtenances. These drawings are provided in Attachment #3 and can be used to inform any future studies into the feasibility of incorporating whitewater features into the Cowichan Lake Weir. The drawings should be interpreted with the project's Preliminary Design Report.

4.0 OPINION ON FEASIBILITY

Stantec has been considering opportunities to incorporate whitewater features into the Cowichan Lake weir since first receiving the feedback from the online survey with the understanding that the main objective of the project is the fishery and fish passage. Dual-purpose recreation and fish by-pass structures have been done before and are feasible in an appropriate setting. All of the projects that we are aware of maintain a permanent head-pond at an elevation above downstream river, even at Zero Supply Level (ZSL), similar to a traditional weir. They do not have gates at the river bed and an operational regime that brings the head differential down to zero.

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Whitewater features need differentials in hydraulic head in order to transfer energy from a super-critical flow profile to a sub-critical flow profile. This is what makes a standing wave and other whitewater features. In addition to the elevation head, either free discharge into sub-critical backwater is necessary to create a feature or the differential must be transferred over a series of geometric changes in a downstream channel. .

Free Discharge into Backwater

Sub-critical backwater that is at an appropriate elevation to create a feature is only present at the weir during high-flow periods. In summer the flow profiles, while sub-critical, are low and shallow. There may be appropriate backwater in shoulder seasons of select years but the problem with relying on only backwater for whitewater features, and no geometric structure, is that you only have the opportunity to make one hydraulic jump before flows return to sub-critical and differential is lost.

When relying on only backwater, a design is limited to a free discharge or a free fall and is not safe nor suitable for recreation.

Option A for the south abutment fishway contemplated a free discharge into a constricted channel and it was found that even a small and narrow trapezoidal channel with an invert at the zero service level (ZSL) risked discharging too much water and draining the lake to ZSL faster than is appropriate or mandated under the operational rule curve. Any whitewater feature at the Cowichan Lake would therefore need to rely on downstream geometric structures to control the backwater in a ramped or stepped fashion.

Discharge into Geometric Structures

Geometric structures that create backwater come in two types. One type is those that constrict flow. This mechanism is similar to that which is used by the existing vertical slot fishway. The others type is ones that raise the invert of the channel using weirs, check structures, ramps, or steps.

Constrict Flow

The existing vertical slot fishways constriction and the backwater created by the slots in the downstream chambers controls discharge through the fishway and makes stepped backwater, and is serviceable over the entire range of operational water levels because of the height of the vertical slots. Whitewater facility design could contemplate such a mechanism to dissipate energy and create hydraulic jumps; however, it is Stantec's opinion that, similar to Option A, such a structure would discharge too much water. Even the relatively small vertical slot fishway is estimated to discharge up to $1m^3/s$ at full service level (FSL). A whitewater feature that utilizes this type of concept in its design would likely discharge water in excess of that which is mandated under the operational rule curve once it is scaled up to be of a suitable size to be used by humans, and their vessels.

Raise the Invert of the Channel

The other form of geometric controls are those that raise the channel bottom invert to force critical depth. This can be done using a ramp to help elongate the slope of a free discharge or weir/check structures to introduce the sub-critical backwater in a controlled and stepped manner. These structures all require inverts that are above the natural downstream backwater and above the channel bottom. In the case of the Cowichan Weir, any such structure would need to be above ZSL and could only operate for periods when the water level is higher than its crest elevation. The higher the feature is from ZSL (e.g., height of ramp or number of steps),

and the more steps that are put into place, the more periods of time in the summer the lake levels will be below its invert and will render the whitewater feature inoperable.

This limitation is the same limitation that drove the design of the south abutment fishway and its ported manifold. Stakeholder feedback for the new fishway indicated the desire to have a natural or nature-like fishway. Such designs typically use step-pools to dissipate energy by transitioning the flow profile from super-critical to sub-critical with geometric controls that raise the invert. While smaller in scale and different in purpose, the design of such step-pools is very similar to the design of backwater features for whitewater. The steps in the fishway need to be present at even intervals of 0.2 m through the approximately 2 m range in water levels during weir operation. A natural channel that discharges only at the top would only be operation for the first 0.2 m of drawdown from FSL. After that, the uppermost weir would run dry and discharge would be zero. This is what necessitated the use of the ported manifold to control discharge and direct it into the pool-step that is associated with the given lake level. The other pools above it at these times would be dry. A whitewater feature that uses a side channel type arrangement faces this same limitation.

In consideration of the size of steps required for a whitewater feature, there is little room within the 2 m range in operational water levels to incorporate very many steps above ZSL. A single low-profile weir or step structure on the downstream end of a channel would create too large a feature when lake levels are high that it would be a hazard. Enlarging the step or using a few steps shortened this differential but means that the channel will be dry for longer periods of time during the operational season.

RISK TO FISH PASSAGE

White water features are not conducive to fish passage for all life stages of fish because by their very nature they serve to speed-up the water and create hydraulic differentials; both of which challenge passage, particularly for small and juvenile fish. While we understand that there are cases where fish passage has been successfully incorporated into white water features, it is more often that fish passage measures are added as a mitigation to the risk to passage that these structures pose. There is also a high potential recreational activity in a dual-purpose channel to affect the behavior fish that are navigating the channel. A dual-purpose fish passage and whitewater channel would introduce a risk to the fish passage objectives of the project.

CONCLUSION

In review of the information presented in this memo, it is Stantec's opinion that adding a whitewater facility or features to the Cowichan Lake Weir is not feasible due to hydraulic, geometric and operational limitations of the site.

Stantec Consulting Ltd.

Original document signed and sealed by Stantec Consulting Ltd. on November 25, 2021

Matt Wood, P.Eng.
Chief Engineer Natural Systems Design
Phone: 403.870-9420
matt.wood@stantec.com

c. C.C. Andrew Bayliss – Stantec